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Woodland Caribou and Their Habitat in Southern and Central British Columbia

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ABSTRACT

We reviewed the status of woodland caribou (Rangifer tarandus caribou) and their relationship to forestry practices in southern and central British Columbia. Our objectives were to summarize and assess the information base and to make recommendations regarding needs for research and for management analysis.

Our minimum population estimate for the study area is 2860 animals. Caribou numbers are believed to have declined overall in historic times, but are currently increasing in some parts of the study area and declining in others. Caribou habitats have been affected by logging, transportation development, insect attack, fires, reservoirs, mining, and recreational activities. Existing information is not sufficiently reliable to support cause-and-effect inferences about the impact of those or other potentially important factors on caribou populations.

The functional relationship between forests and caribou is discussed. Of the forest resources important to caribou, arboreal lichen production is the most difficult to accommodate in forest management plans. Special forestry practices that have been proposed for harvesting timber while maintaining lichen production are reviewed.

Deficiencies and potential biases are identified in historic and recent inventory data, historic harvest data, and methods of studying food habits and habitat selection. Recommendations are made for improving methodologies.

Management objectives for caribou in the study area can best be met if planning is carried out at a provincial level to designate certain areas in which caribou management is accepted as a high priority. We developed a framework to help managers view caribou management considerations in a broad geographic context. By applying our framework, we produced overlay maps showing biological viability of caribou, public use and interest in caribou level of knowledge about caribou, degree of habitat disturbance, and conflicting land use pressures. We recommend the designation of three caribou population centres as high-priority management areas: one centred around Tweedsmuir Park, one centered around Wells Gray Park, and one between Prince George and the Alberta border. Medium-priority caribou management areas should be selected at the regional level. Concentration of effort into the high- and medium-priority management areas should allow other areas to be managed without costly constraints due to caribou.

We developed and applied a research framework to assist us in identifying the topics on which information is most needed. There is a high-priority need for better inventory: identification of populations, determination of population dynamics, and determination of distribution. Research is needed to improve methods of obtaining information on numbers and composition of populations. Other key research needs include an investigation of year-round energetic relationships of caribou, and a study of proximate mortality factors and their relationship to man-caused changes in the habitat. To ensure that information obtained in local studies becomes available for synthesis, we recommend that research and inventory be co-ordinated at a provincial level.

SUMMARY

1 INTRODUCTION

We reviewed the status of caribou and their relationship to forestry practices in southern and central British Columbia. Our objectives were to summarize and assess the information base and to make recommendations regarding needs for research and for management analysis.

The geographic area of the study was that portion of British Columbia lying south of Highway 16 between Prince Rupert and Prince George, and south of Highway 97 between Prince George and Dawson Creek. Interviewing and data collection took place in 1982. Major points, but not details, were updated in 1984.

We refer to caribou occupying ranges in the western portion of the study area and east of the Rocky Mountains as "northern caribou". Winter snow conditions in the range of northern caribou commonly permit the use of terrestrial vegetation as forage. We refer to caribou in the remainder of the study area as "mountain caribou". In the range of mountain caribou snowfall is heavier, and arboreal lichens are a major component of the winter diet.

2 STATUS OF CARIBOU AND CARIBOU HABITAT

Caribou Populations

The overall distribution of caribou in the study area has diminished in historic times.

There is evidence, mostly subjective, that caribou populations over most of the study area declined significantly in the 1930's, remained at low levels through the 1940's, then increased in the 1950's to peaks in the mid- to late 1960's, after which they again declined. In recent years, populations in four of eight sub-areas (Thompson-Okanagan, North and South Tweedsmuir, Telkwa) are known or suspected to be increasing at least slightly, three others (Kootenay, Quesnel Highland, Omineca) are suspected to be decreasing, and the last (Northeast Coal) is too poorly known for a trend estimate.

Based on available information, the current minimum population estimate for the study area is 2860 animals, a figure 36% higher than that (2109) determined by Bergerud (1978). Approximately 25% of the current estimate

(711) was tallied in the Itcha-Ilgachuz area of Region 5, and that herd is the largest in the study area. Just over 50% of the animals in the current estimate (1450) are the mountain ecotype, and the rest are the northern ecotype, which also occurs in remaining British Columbia caribou range, outside the present study area.

During the mid- to late 1960's, very liberal hunting regulations were in effect over most of the study area, and some large harvests apparently occurred during that period. It is commonly believed that overhunting caused or contributed to the post-peak declines in some areas, for example Telkwa, north Tweedsmuir, Omineca, and the central Selkirks. There is some supporting evidence in those cases, although the official harvest data are not conclusive. There are indications of greatly increased hunting pressure in small areas as a result of new access or transportation methods (i.e. helicopters), and we consider it likely that local population declines have occurred in such cases.

The trend since 1975 has been for increasing hunting restrictions, including shortened seasons, removal of either-sex opportunities and many local closures. As of 1982, only 13 of 79 Game Management Units in the study area (16%) had open seasons for caribou and harvests in that area over the past five years have averaged only about 27 animals per year, i.e., less than 1% of the estimated minimum population. Further, about 85% of that kill has been in the Itcha-Ilgachuz area of Region 5.

Caribou Habitat

Seasonal habitat use: Northern caribou are often observed to winter on windswept alpine slopes or in muskegs, where they dig through snow for terrestrial vegetation. They sometimes winter in lodgepole pine stands or other forests, where their pattern of resource use is poorly known.

Two broad patterns of winter habitat use have been observed among mountain caribou. When the snowpack is settled, they commonly feed on arbooreal lichens in high-elevation forests. Many high-elevation ranges in the study area have been identified. Under soft snow conditions mountain caribou are more likely to use low- or mid-elevation forests, where they feed on vascular plants and

lichen litterfall. Few low-elevation ranges in the study area have been identified.

Mountain caribou have been observed to feed on green vegetation, usually at low elevations, during spring. Spring habitat use of northern caribou is poorly known.

Young calves of northern caribou have often been seen in alpine habitats. The few calving sites known for mountain caribou are on alpine slopes and in timberline forests. It is possible that both ecotypes also use other habitats, which have not been identified.

During summer, both ecotypes are most commonly found in alpine and subalpine meadows and on snow patches, although use of lower elevations also occurs.

Little is known of the habitat characteristics of rutting areas, and few specific rutting areas have been identified.

Caribou make lengthy altitudinal and horizontal movements between and sometimes within seasons. Movements of 153 km or more occur. Little is known of the effects of habitat alterations and linear developments on caribou movements in the study area.

Factors affecting caribou habitat: Logging in caribou ranges began earlier in the southern and eastern parts of the study area than in the north and west. Where logging has occurred in caribou ranges, it is predominantly patch clearcutting with little or no residual timber. In some areas, there are stands with large amounts of residual timber that resulted from partial cutting systems used before 1966. In a few instances, diameter-limit logging is used currently in caribou ranges in an effort to preserve a lichen-bearing stand.

Although variations exist, the most common silvicultural prescription in spruce-subalpine fir and cedar-hemlock types is to clearcut, broadcast burn or windrow and burn, and plant spruce. A backlog of untreated, unplanted cutblocks exists. Lodgepole pine types are clearcut, are sometimes scarified, and are left to regenerate naturally. Juvenile spacing of lodgepole pine is planned, but little is done at present.

Transportation corridors and access have been related to harassment, increased hunting mortality, and collision mortality in the study area.

Although some access to caribou ranges exists in all regions, several large areas and a number of small ones remain inaccessible.

Large wildfires are considered to have a negative impact on habitat values where they have occurred in mountain caribou ranges: the southern Selkirk and Purcell Mountains, the Canadian Pacific Railway corridor, the Wells Gray Park area, the southern Quesnel Highland, and parts of the Prince George Region. In northern caribou ranges, where fire frequency is historically high, the impact of fires on caribou habitat is probably beneficial in the long term.

Severe spruce beetle and mountain pine beetle infestations in parts of the study area are resulting in intensified timber harvesting in caribou ranges.

In addition to fire, logging, transportation corridors and access, caribou in the study area have been affected by impoundments for hydroelectric developments, prospecting and mining, and recreational activities.

Status of habitat in caribou ranges: We used the Mark IV data base of the Ministry of Forests Inventory Branch and maps prepared from Landsat imagery to describe the status of habitat in low- and high-elevation caribou ranges. In the range of the mountain caribou ecotype, high-elevation winter ranges are composed of spruce-balsam forest, alpine forest, and alpine areas; low-elevation winter ranges are composed of cedar-hemlock and spruce-balsam stands. Amounts of immature and understocked types are variable, but most ranges have been affected by forest harvesting. In the range of the northern ecotype, alpine areas are an especially large component of many high-elevation winter ranges; low-elevation ranges are composed of mature and immature lodgepole pine and sometimes nonproductive forests. Most ranges of the northern caribou ecotype have been affected considerably by fire, and little by logging.

Forest management planning: The pressure to harvest timber on caribou ranges depends on the timber supply situation in Timber Supply Areas (TSA's) and on a complex of local factors. In many parts of the study area, some degree of falldown in the timber supply is projected. Many TSA's face special short-term or long-term supply problems, or both.

Habitat protection: A variety of habitat protection measures have been applied in mountain caribou ranges in an effort to maintain mature, lichen-bearing timber in wintering areas: modifications to the size and

location of cutblocks, selective logging, and small reserves. In northern caribou ranges few habitat protection measures related to logging have been taken, either because conflicts have not been identified or because managers do not have the biological information they need in order to handle them. In the Northeast Coal area, habitat protection efforts have focussed on protecting caribou from mining activity.

3 FOREST MANAGEMENT AND CARIBOU

We identified the following forest resources that are important to caribou: forage (arboreal lichens, terrestrial lichens, vascular plants), temporary shelter (snow interception, prevention of snowcrusting), escape cover, and insect relief cover. Two characteristics important to caribou are best developed in mature forests: the production of arboreal lichens, and the simultaneous provision of forage and snow interception. We reviewed the forestry practices that have been used or proposed in mountain caribou ranges.

Partial cutting has the potential for minimizing the loss of the arboreal lichen resource, because some lichens are retained on residual trees, and because lichen abundance is expected to increase more rapidly than it would after clearcutting. Those advantages must be assessed within the overall harvesting plan, taking into consideration: timing and anticipated consequences of later cuts, possible increases in road development and therefore access, road and harvesting costs, likelihood of blowdown, and silvicultural consequences.

Retention of advanced regeneration and nonmerchantable trees would not result in as great a lichen crop as partial cutting, but avoids some of the disadvantages of partial cutting.

Clearcutting in very small patches has the potential of enhancing lichen production in the leave patches; like partial cutting, its advantages must be assessed within the overall harvesting plan.

In the long term, extended rotation, in conjunction with other special forestry practices, is the harvesting strategy with the greatest potential for perpetuating arboreal lichen production. However, it has a high cost in terms of growth and yield of timber.

The option of progressive cutting, some of which must be partial cutting, should be considered where it would allow adjacent, undeveloped drainages to remain undisturbed for some time.

The development of roads in previously inaccessible areas is a serious consequence of logging in caribou habitat; access control is an option that should be considered where caribou management is a high priority.

The reservation of some areas from human activity may be necessary where caribou management is a very high priority.

Any special forestry practices that are proposed for maintaining lichen production must be evaluated in terms of a) the long-term forest management plan and b) a possible increase in the area that is being harvested at any one time.

4 EVALUATION OF THE INFORMATION BASE

Both historic and recent data on caribou numbers were found to be deficient in many ways. The lack of a reliable and consistently applied inventory system is seen as a continuing impediment to our understanding of caribou populations in the area. A primary need relative to inventory of caribou in the study area is identification and description of the actual populations present, as defined by biological rather than geographic criteria.

Several deficiencies and potential biases were identified among both historic and recent harvest data for caribou, with the result that most area-specific trends could not be reliably determined. The Compulsory Inspection system appears to produce high quality data on hunter kill, but it was not instituted until after most of the present area had been closed to hunting.

Problem areas associated with existing data on habitat use and food habits include: biases inherent in inferences about habitat use that are based on animal locations obtained without telemetry, conclusions about habitat selection that are not based on use/availability analyses, and the questionable reliability of fecal analysis and other methods of determining food habits.

5 MANAGEMENT ANALYSIS

The management objectives of the British Columbia Ministry of Environment for caribou in the study area are to maintain or increase numbers on traditional ranges in the major biophysical zones in which the species naturally occurs. To meet those objectives, managers need to place priorities on geographical areas for caribou management. We developed a framework intended to help managers view caribou management considerations in a broad geographic context, and thereby to select areas for high- and medium-priority caribou management. By applying our framework, we produced overlay maps showing biological viability of caribou, public use and interest in caribou, level of knowledge about caribou, degree of habitat disturbance, and conflicting land use pressures.

We used the resulting combinations of map overlays as a basis for recommendations regarding management priorities.

Management recommendations

Caribou management should be provincially co-ordinated so that regional inventory and research results and management decisions are consistent and comparable.

To reduce the uncertainty associated with past hunting data, an attempt should be made to reprogram those data.

In selecting management strategies, managers should consider geographic differences in how caribou relate to their habitat.

Managers should consider the implications of biogeographic principles when placing priorities on geographic areas to be managed for caribou production.

Some areas should be designated in which caribou management is a high priority.

Designation of high-priority caribou management should be done at a provincial level.

We recommend the following caribou population centres as high-priority management areas: Tweedsmuir Park and adjacent land to the east; Wells Gray Park and adjacent land to the east and west; parts of the Upper Fraser drainage east of Prince George.

Key caribou ranges in high-priority management areas should be identified.

Management constraints in key caribou ranges in high-priority management areas should be restrictive. For mountain caribou, we recommend the following: 1) no industrial development, or 2) access control, partial cutting and extended rotation. For northern caribou, we recommend: 1) no industrial development or 2) access control and restriction of logging to areas peripheral to key ranges. Those constraints may be modified as more information becomes available.

Some areas should be designated in which caribou management is of medium priority. Medium-priority management areas should be selected, and management strategies determined, at a regional level.

Caribou populations in high- and medium-priority management areas should be inventoried regularly.

Areas not designated as high or medium in priority for caribou management should be managed without costly constraints due to caribou.

6 RESEARCH NEEDS

We developed and applied an a priori research framework to assist us in identifying topics that require investigation through inventory, research, or both. Those topics are grouped below according to priority rating. Topics that are rated low to moderate in priority do not necessarily warrant investigation on their own, but researchers and managers should be aware of the need to gather relevant information when opportunities present themselves.

Inventory topics

High priority

- Identification of populations, determination of population dynamics, determination of distribution.

Moderate priority

- Natality assessment

Low to moderate priority

- Evaluation of the use of thermal, hiding and insect cover (through collection of data on local distribution).

Research topics

High priority

- Development of methods for obtaining information on numbers and composition of populations
- Predation and its relationship to man-caused changes in the habitat
- Energetics, including:
 - a) factors affecting the seasonal energetic status of caribou;
 - b) relationships between forested habitat and the action of those factors on caribou;
 - c) relationships between the energetic status of caribou and their productivity and natality.

Moderate to high priority

- Magnitude of proximate mortality factors (poaching, traffic fatalities, accidents, etc., and their relationship to man-caused changes in the habitat

Moderate priority

- Determination of age at first breeding on various ranges

Low-moderate priority

- Evaluation of the use of thermal, hiding and insect cover (through research activities)
- Mineral nutrition on various ranges

Interactions among topics

We identified a set of broad biological questions, which we feel should guide the inventory and research activities undertaken under the categories listed above:

- What is the relative impact on caribou of access development vs. habitat alteration in their ranges?
- Why do caribou select the habitats they do?
- What are the relationships among the quality and quantity of caribou habitat, caribou numbers, and animal condition?
- What are the relationships between animal condition and the response of caribou to stresses, such as predation, human disturbance, and insect harassment?

What are the relationships between caribou numbers and climatic variations over time and space?

What is the optimum size, shape and arrangement of habitat reserves for caribou?

What variations in habitat selection strategies exist within ecotypes, and what are the implications of those variations for managers and researchers?

The following two questions also involve interactions among topics, but are primarily methodological in nature:

What are the theoretical, statistical, and practical problems involved in comparing use and availability of habitat types and how can they be resolved?

What are the optimum conditions and methods for relocating caribou?

Conclusions

Potential research study areas must be screened for a variety of factors that affect their suitability, but we recommend that first consideration be given to the three population centres recommended for high-priority caribou management.

To ensure that information obtained in local studies becomes available for synthesis, we recommend that caribou inventory and research be co-ordinated at a provincial level.

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1 INTRODUCTION

Forest and wildlife managers in British Columbia are faced with the problem of managing forests to produce both timber and caribou. Caribou numbers have declined in parts of the province, and many biologists believe that habitat changes have contributed to the decline. In some areas, disagreements about resource allocation in caribou ranges have resulted in unresolved conflicts. Even where no controversy has developed, managers foresee problems as timber harvesting moves into more remote areas. Managers in the Ministry of Environment and Ministry of Forests alike are frustrated by inadequate information on the general biology, habitat requirements, distribution, and population status of British Columbia caribou. Before a major research program is undertaken, a review is required of the status of caribou and their relationship to forestry practices.

1.1 Objectives

The objectives of the study are:

- i. To review and assess available information on the distribution, population status, and management (including harvest) of caribou in southern and central British Columbia;
- ii. To review, by region, the existing information on seasonal habitat use, food habits, and other aspects of the animals' ecology;
- iii. To review, by region, the patterns of forest harvesting, silvicultural treatment, fire history, insect attack, and other human activities and natural phenomena that affect caribou habitat;
- iv. To describe the pattern and age of forest stands currently available to caribou;

- v. To review the status of forest management planning and the pressure on the timber supply in the Timber Supply Areas (TSA's) that support caribou, in order to assess the potential impact of the timber supply on the animals;
- vi. To review current policies for habitat protection in caribou areas, and the options that are available for integrating caribou management and timber harvesting;
- vii. To review the current ideas about factors affecting numbers of large ungulates, especially caribou;
- viii. To assess the extent and quality of currently available information;
- ix. To make recommendations regarding research topics, hypotheses, priorities, and study areas;
- x. To make recommendations regarding needs for management analysis.

1.2 Study Area and Period of Study

The geographic area of the study is the southern half of British Columbia, that is, that portion of the province lying south of Highway 16 between Prince Rupert and Prince George, and south of Highway 97 between Prince George and Dawson Creek (Fig. 1). Those boundaries were chosen because the potential problems arising from timber harvesting in caribou habitat are more severe and immediate in that part of the province than in the north.

Our study lasted from 1982-1985. Most interviewing and data collection took place in 1982. Major points, but not details, were updated in 1984.

1.3 User's Guide

1.3.1 Organization of the report

The main body of the report is composed of one lengthy descriptive chapter and four briefer synthetic chapters.



Chapter 2 addresses Objectives i, ii, iii, iv, v, and the first half of Objective vi; it is a review by region of the available information on caribou populations and habitat. Our methods are described in Section 2.1.1. The main body of Chapter 2 is structured so that the account for each administrative area can serve as a separate and complete working reference document for local managers and researchers. For that reason, some repetition and duplication of evaluation statements and descriptive material is unavoidable. The intent is to make it unnecessary for a manager to refer to the account for another region to understand arguments pertaining to his own. Each regional account is composed of four sections: a discussion of caribou populations, a discussion of caribou habitat, a summary of local information needs, and a list of published and unpublished sources of information on caribou in the region.

As will be evident, information on caribou populations in the study area is greatly scattered both in time and space. The chore of drawing it all together is a major one which, we believe, should not have to be done more than once. Accordingly, the treatment of data available for each area through August 1982 is as exhaustive as possible. Conclusions, interpretations, and hypotheses on local populations and population changes, as proposed by managers and previous researchers, are considered and discussed in relation to the area-specific data available. The objective is to describe what is known about the history and current status of caribou numbers in each area and to indicate how well-supported that knowledge may be. Areas with apparent or potential overlapping estimates (the same animals in more than one place) are pointed out. In most cases, current estimates can be judged, but can be neither revised nor refined without additional field data. Nevertheless, we occasionally propose alternate interpretations, and for a few areas where no previous estimates exist, we generate new minimum population figures.

All significant data on natality and mortality are considered in relation to interpretations of both historic and current population numbers and trends. Data gaps and inconsistencies are identified and discussed. The history and current status of hunting opportunity and harvest are presented for each area, both because they include the only mortality data regularly and consistently available and because mortality from hunting is the main

population dynamics factor that managers have had control over, especially in the past three decades.

There was an active predator control program, directed primarily at wolves (Canis lupus), over much of the province from about the late 1930's through at least the 1950's. Tompa (1983) has documented the general provincial trend in wolf control pressure over the years in terms of numbers of animals bountied, taken for fur, or poisoned by government staff. Unfortunately, the available data are not specific enough to allow determination of local trends. We acknowledge that some of the caribou populations in the study area were likely benefited by locally reduced predator populations, but we do not know which ones, or when. For that reason, most of the regional accounts do not discuss predator control activities.

It was beyond the scope of this report to conduct a detailed analysis of historic weather patterns in the various areas discussed, but weather effects could have been important at times, e.g. see Elliot et al. (In prep.). Such effects need not have been direct, resulting in mortality or reduced natality, to have had impact on our understanding. Weather-induced changes in distribution affect counts, and most analyses consider all available counts at face value. Studies on radio-collared caribou in the Spatsizi Park area of northern British Columbia have documented the relative countability of animals under differing snow conditions, and have shown that deep snow conditions may stimulate long-distance movements, i.e., away from areas normally censused (Hatler 1983; unpubl. data).

The discussions of caribou habitat within regions include considerations of a variety of factors that are believed to affect caribou, such as logging, fires and road development. The general effects of those factors on caribou are described in Section 2.1.2. For each region we discuss the status of the timber supply within caribou habitat. The implications of the timber supply to caribou management are discussed in general in Section 2.1.3.

In Chapter 3, we discuss the functional relationships between caribou and forests, and examine special forestry practices that are in use or have been proposed for caribou habitat (second half of Objective vi).

In Chapter 4, we examine methodological problems that we identified in our review of the information base in Chapter 2 (Objective viii).

In Chapter 5, we develop a rationale for an approach at the provincial level to meeting management objectives for caribou (Objective x). Our analysis of management needs involves setting priorities on caribou management within specific geographic areas. The methods we developed for that process are described in Section 5.3.1. In Section 5.4, we summarize the management recommendations made in this and earlier chapters.

In Chapter 6, we bring forward information needs that were identified in earlier chapters. We briefly consider aspects of population regulation in caribou (Objective vii). We then develop a framework for systematically identifying needs for inventory and research; our methods are described in Section 6.2.1. The application of the framework results in a set of recommendations intended to form the basis of a research program (Objective ix).

Included in Volume 1 are the Appendices that we considered most essential to the understanding of the report. The remaining Appendices and the maps of Caribou Ranges, Caribou Observations, Fire History, and Insect Attack for each of the seventeen 1:250 000 NTS maps covering our study area are located in Volume 2.

1.3.2 Terms and concepts

We refer to caribou occupying ranges in the western portion of the study area and east of the Rocky Mountains as "northern caribou". Northern caribou inhabit a geographic area in which winter snow conditions commonly permit the use of terrestrial vegetation as forage. We refer to caribou in the remainder of the study area as "mountain caribou". In the range of mountain caribou snowfall is heavier, and arboreal lichens are commonly used as winter forage. The ranges of northern and mountain caribou are shown in Fig. 1. The rationale for the distinction between the types is explained more fully in Section 5.1.

In the sections on numbers, status and management of caribou in the study area, two words appear regularly and should be defined:

1. The term "population" is used loosely, referring most often only to the group (or groups) of caribou being discussed, i.e., those

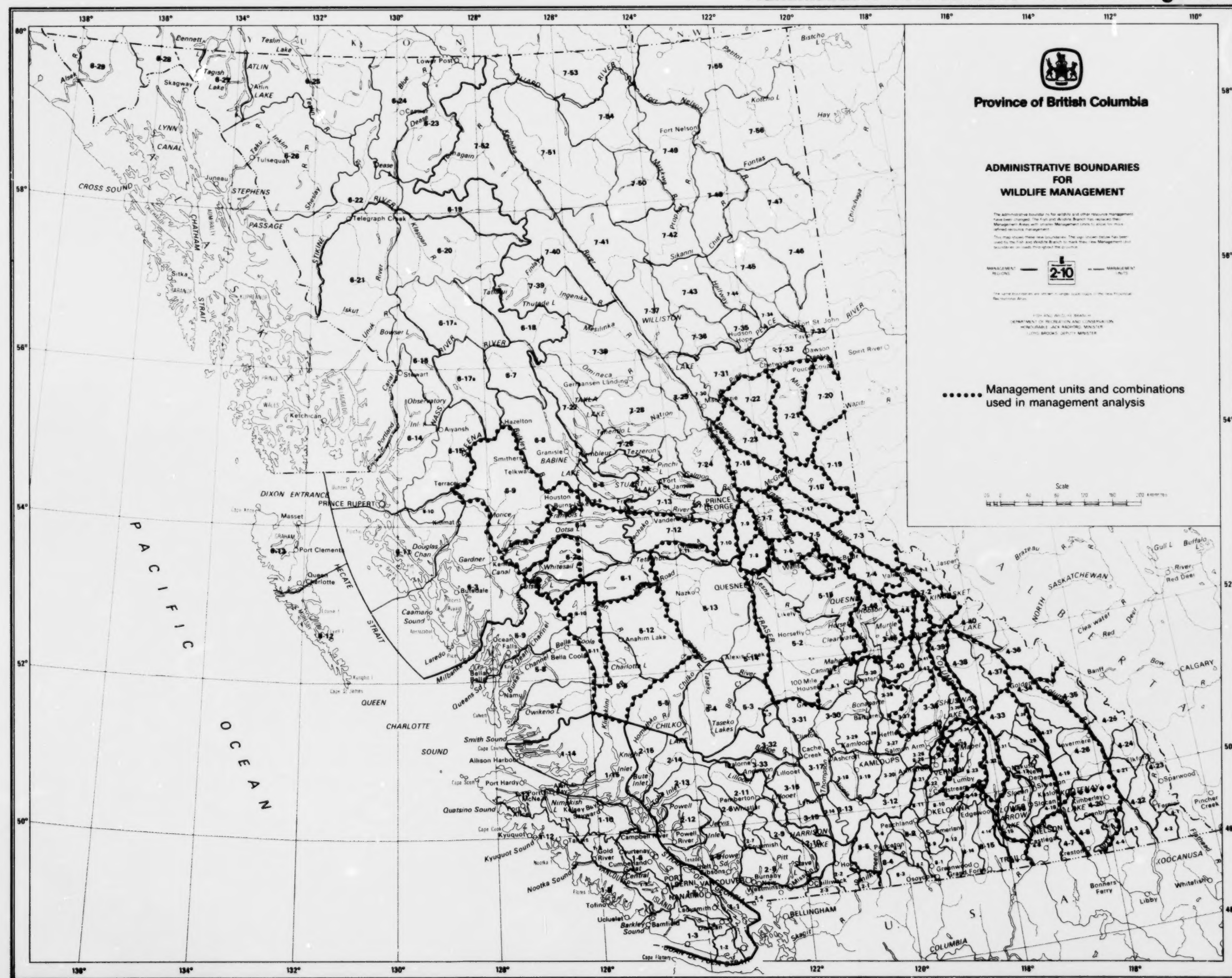
associated with a particular geographical area. This arise as a practical necessity from the fact that the primary focus here is habitat, and habitat occurs in discrete patches enclosed within discrete administrative boundaries. Management responsibility is defined by those boundaries, not by any real population boundaries in the sense of closed biological systems. We believe that Bergerud's (1978) term "herd" is essentially parallel to our "population".

2. "Management", as used in Chapter 2, refers primarily to considerations of hunting regulations and harvest over the years.

References to biogeoclimatic zones are abbreviated and follow Pojar (1983). The zones are listed in the Glossary and List of Abbreviations at the end of this volume, as are other abbreviations and technical terms.

References to the agencies and administrative units of the provincial government apply to the organization that existed up to 1983. The boundaries of the Ministry of Environment and Ministry of Forests are shown in Fig. 2. Most of our population figures refer to Game Management Units (GMU's) of the Ministry of Environment, the administrative subdivisions in the province since 1975 (Fig. 3). Where appropriate, we also consider numbers in areas with other boundaries, as specified by managers and previous researchers. A potentially confusing aspect of the accounts on numbers is the frequent reference to previous administrative units into which the province was subdivided prior to 1975. The present study area was contained in 13 Game Management Areas (GMA's) from 1956-1966, 18 Management Areas (MA's) from 1967-1974, and 79 GMU's since 1975, and the boundaries of the smaller units frequently cross or overlap those of the larger ones. A complete discussion of how administrative boundaries may affect our understanding of caribou in the study area is given in Section 4.1.





2 STATUS OF CARIBOU AND CARIBOU HABITAT BY REGION

2.1 Introduction

In Chapter 2 we review by region the available information on caribou distribution, population status, management, seasonal habitat use, habitat status, and the factors affecting habitat status. In Section 2.1.1 we describe our methods for doing this. In Section 2.1.2 we describe the manner in which habitat changes--logging, transportation corridors and access, fire, insect attack, mining, and other developments--are believed to affect caribou. In Section 2.1.3 we describe the possible implications of the timber supply situation to the management of caribou habitat.

2.1.1 Methods

General

We interviewed Fish and Wildlife (Ministry of Environment) staff at regional and subregional offices, and contacted Parks Branch (Ministry of Lands, Parks and Housing) personnel at the regional level and in Victoria. At the regional Ministry of Forests offices, we interviewed staff from Timber Management, Planning, Silviculture, and Protection. We also contacted persons from other government branches and administrative levels who were referred to us because of their special knowledge of caribou or caribou/forestry problems. We interviewed researchers regarding ongoing or unpublished caribou studies, and we recorded caribou observations reported to us by other individuals, although we did not systematically interview persons outside the government, other than researchers.

We reviewed published and unpublished literature, searched Fish and Wildlife files, and recorded caribou sightings from Canada Land Inventory (C.L.I), Resource Analysis Branch (RAB), and Terrestrial Studies Branch (TSB) survey flights.

Caribou populations

We recorded information about caribou on three sets of overlays for the seventeen 1:250 000 National Topographic System (NTS) maps that covered our study area:

Caribou Observations: We listed (Vol. 2, Appendix 1) and mapped all specific sightings of caribou that we considered reliable.

Miscellaneous Caribou Information: We recorded caribou ranges, movement routes, and miscellaneous information mapped by others or reported to us by others.

Caribou Ranges: We mapped low-elevation and high-elevation winter ranges, movement routes, and mineral licks used by caribou. The distinction between low-elevation and high-elevation winter ranges varies with latitude and topography, but corresponds roughly to the boundary between the continuously-forested and the open-canopied areas of the ESSF zone. The information on the Caribou Range overlays is inferred from the overlays showing Caribou Observations and Miscellaneous Caribou Information.

The maps of Caribou Observations and Caribou Ranges are included in Volume 2. The maps of Miscellaneous Caribou Information are on file with Research Branch, Ministry of Forests, Victoria.

Data on caribou numbers in the study area were assigned primarily in reference to wildlife administrative units (GMU's) as designated in hunting regulations for 1982-83. All sightings among our records, including those made incidentally as well as those from official surveys, were considered in relation to each other to produce a detailed record of the maximum numbers that could be documented on an area and time-specific basis. Those numbers, together with a description of the procedures and rationale for their inclusion, are presented in Appendix 1.

To facilitate historical comparisons of populations, regulations and harvest, we prepared a table relating present GMU's to previous administrative designations (GMA's and MA's) in the study area (Appendix 2). We also assembled a historical review of caribou hunting regulations in the area, including a general narrative for the years through 1955 and a detailed list, by GMU, from 1956 through 1982 (Vol. 2, Appendix 4).

Most data on caribou killed by hunters through 1963 were not sufficiently area-specific for use in this report. A system of questionnaires to sample resident hunters was instituted by the provincial Fish and Wildlife Branch in

1964, and our primary data on resident harvests are mean estimates as listed in annual compilations from that source (Hunter Questionnaire/Hunter Sample). In 1978 a "Compulsory Inspection" regulation was established for caribou. That regulation requires all successful caribou hunters to report to a Fish and Wildlife centre and present pertinent data and specified portions of the carcass for inspection. We supplemented Hunter Sample data with that obtained from Compulsory Inspection for the years 1978-1982. Data on non-resident kill are not available in a readily retrievable form for most years prior to 1978 (J. Bone, pers. comm.). Figures for "guided kill" (not necessarily all non-residents) were presented in Hunter Sample volumes for some years, and were used when available.

The above activities related primarily to Objective i.

Caribou habitat

We summarized the available information on seasonal habitat use, movement routes, and special habitats within each region (Objective ii). Our summaries are based on interviews, literature, government files, and our caribou map overlays.

For each region, we reviewed the factors affecting caribou habitat (Objective iii) and the current status of the stands available to caribou (Objective iv). The factors affecting caribou habitat include logging, transportation corridors and access, fire, insect attack, mining and other developments. In addition to the general methods described above, we used the following special methods to meet Objectives iii and iv:

Fire History: We mapped all burns extending at least 1.6 km in any one direction that were recorded in the Provincial Fire Atlas, Ministry of Forests Protection Branch, Victoria. The Fire Atlas includes only fires that occurred since 1940 or (in a few areas) 1950. Fire boundaries were transferred by eye from the 1:125 000 Fire Atlas maps to our 1:250 000 overlays. The Fire History maps are included in Volume 2.

Insect Attack: Areas of current attacks by spruce beetles (Dendroctonus rufipennis) and mountain pine beetles (D. ponderosae) were mapped, based on

information provided by Ministry of Forests Regional Pest Management Co-ordinators. The Insect Attack maps are included in Volume 2.

Status of habitat in caribou ranges - Landsat mapping: Five broad land cover/land use classes were mapped from 1:250 000 Landsat cibachrome prints by K. Watson of International Range Remote Sensing Ltd. The classes mapped were clearcut logging, partial cut logging, mature conifer forest, immature conifer forest, and "other" (Vol. 2, Appendix 3). Because of budget constraints, Forest Status maps were prepared only for the 13 NTS mapsheets in the eastern portion of the study area (Vol. 2, Fig. 1), where caribou/forestry management problems are more severe. The Forest Status maps are on file with Research Branch, Ministry of Forests, Victoria.

Status of habitat in caribou ranges - forest inventory: Because caribou winter ranges are regarded as critical, we obtained further detail on the status of habitat within the low- and high-elevation winter ranges shown on the Caribou Range maps (Vol. 2) from the Mark IV computerized data base maintained by the Ministry of Forests Planning and Inventory Branch. To describe forests in areas that had been surveyed before 1976, we used NTS map grid overlays on our Caribou Range maps. Individual grids measure $1\frac{1}{4} \times 1\frac{1}{4}$ minutes; actual area varies with latitude. Caribou ranges located in areas surveyed in 1976 or later could not readily be described from our 1:250 000 maps, most of which lack Universal Transverse Mercator (UTM) lines. In those cases, we transferred the caribou ranges to 1:600 000 maps with a mapograph, and used 2000-m² UTM grids to describe the ranges located in areas that had been surveyed on a metric base.

The Mark IV output consisted of an area statement by forest cover type for each of the 87 winter ranges we identified. We grouped the Mark IV data into the following 19 categories according to the Type Identity, Type Group and Basic Class of the B.C. Ministry of Forests (1980):

Immature timber (IM) - coniferous stands (except lodgepole pine)
less than 121 years old; lodgepole pine and deciduous stands
less than 81 years old (Type Identity 1);

Mature cedar - hemlock (CH) - stands 121+ years old having western redcedar or western hemlock as the leading species (Type Identity 2, Type Groups 9-17);

Mature spruce - balsam (SB) - stands 121+ years old having Engelmann spruce, white spruce, or subalpine fir as the leading species (Type Identity 2, Type Groups 18-26);

Mature lodgepole pine (PL) - stands 81+ years old having lodgepole pine as the leading species (Type Identity 2, Type Groups 28-31);

Mature white pine (PW) - stands 121+ years old having white pine or white-barked pine as the leading species (Type Identity 2, Type Group 27);

Mature Douglas-fir (FIR) - stands 121+ years old having Douglas-fir as the leading species (Type Identity 2, Type Groups 1-8);

Mature deciduous (DEC) - stands 81+ years old dominated by any deciduous species (Type Identity 2, Type Groups 35-42);

Residual (RES) - stands remaining after partial cutting (Type Identity 3);

Not sufficiently restocked (NSR) - stands that have been more than 75% disturbed by fire or logging and have not been adequately restocked with commercial species (Type Identity 4);

Non-commercial timber (NC) - (Type Identity 5);

Alpine (A) - (Type Identity 6, Basic Class 02);

Alpine forest (AF) - (Type Identity 6, Basic Class 10);

Non-productive forest (NP) - (Type Identity 6, Basic Classes 11-12);

Rock (Roc) - (Type Identity 6, Basic Class 03);

Swamp (SW) - (Type Identity 6, Basic Class 35);

Water (W) - (Type Identity 6, Basic Classes 15 and 25);

Open range (OR) - (Type Identity 6, Basic Class 63);

Disturbed, stocking doubtful (DSD) - (Type Identity 7);

Other (e.g. gravel pits, sand flats, roads).

The results of the Mark IV analysis are presented in Figs. 4-11 and in Vol. 2, Appendix 2. The winter ranges for which forest inventory information was obtained are identified by reference numbers in Figs. 4-11, on the Caribou Range maps (Vol. 2), and in Appendix 2 (Vol. 2). Because the areas for Mark IV analysis were defined on a grid system, their boundaries do not correspond exactly to the boundaries shown on the Caribou Range maps. Boundary discrepancies resulted in some errors in the analyses, especially those of small caribou ranges. We were unable to obtain forest inventory information for caribou ranges located in Federal or Provincial Parks, Tree Farms or Tree Farm Licenses, because the Mark IV data base is limited to unalienated Crown land administered by the province. Our comments on the status of habitat in winter ranges are based primarily on the Mark IV analysis. Landsat mapping (Vol. 2, Appendix 3) was used as a back-up information source, mainly to determine the presence or absence of forest harvesting within a range.

The Mark IV data base was current as of 1983. The dates of Landsat images varied from one area to another and ranged from 1977 to 1981.

For each region, we discussed forest management planning and the potential impact of the timber supply situation on caribou (Objective v). Pressure to

harvest timber within caribou habitat is related to the overall timber supply in the Timber Supply Areas (TSA's) in which the habitat is located. We used Ministry of Forests Yield Analysis Reports for TSA's, Allowable Annual Cut Determinations and Rationale Statements for TSA's, and information provided by Regional Planning Officers as the bases for our discussions of the timber supply situation. In any given caribou range, the pressure to harvest timber depends on a complex of local factors, as well as on the overall timber supply situation in the TSA. We did not have any method for systematically assessing the harvesting pressure in areas smaller than TSA's. The local considerations that came to our attention are reported, but our analysis is primarily a generalization from the TSA level.

For each region, Fish and Wildlife policies and practices for protecting caribou habitat are reported (Objective vi). We discuss special management problems which have arisen and situations in which other groups have become involved in habitat protection.

2.1.2 Habitat changes and caribou

In the main body of this chapter, we describe by region changes that have occurred or are occurring within caribou habitat -- logging, roads and other linear developments, fires, insect attacks, mining, and other human activities. The hypothesized impacts of those changes on caribou are described below.

Logging potentially affects caribou in several ways. An increased forage supply is temporarily available in the form of lichens on felled trees. The supply of lichen forage is then reduced or eliminated, depending on the type of logging, for a long time. By altering the forest canopy, timber harvesting affects the abundance of vascular forage, and the value of the stand as cover. Logging roads affect caribou by creating access into their ranges. A number of logging systems, which vary in their impact on caribou, have been used in different parts of the province. The functions of forests in the ecology of caribou, and the impacts of various forest management techniques, are discussed further in Chapter 3.

The potential effects of roads and railroads on caribou are also complex. There is little evidence that the structures themselves actually block

movement, although they may deflect traditional movement routes (Bergerud et al. 1984). In British Columbia, caribou are known to cross railroads and major highways at a number of locations.

Caribou usually show much greater alarm in response to traffic and human activities than to the transportation corridors themselves; barren-ground caribou (Rangifer tarandus groenlandicus) feeding near roads were observed to discontinue feeding with each passing vehicle, thus decreasing rates of forage intake during feeding bouts (Klein 1980). Vehicular traffic may cause caribou to retreat from highways. Stevenson (1979, Appendix D) observed a cow and calf repeatedly approach a highway, and then retreat when a vehicle approached. According to Klein (1980), large vehicles, fast-moving vehicles, and clouds of dust or snow evoke especially strong avoidance responses.

Where highways cross caribou ranges, vehicle collisions are a source of caribou mortality. Caribou often fail to flee from passing vehicles, or may run along the road rather than away from it. The cow and calf observed by Stevenson (1979, Appendix D) eventually gained access to the highway, and then remained on the roadway while a car passed in the other lane. Salt, applied to highways during winter, contributes to the risk of collisions by making highways attractive to caribou.

Railroad trains also pose a collision hazard to caribou. The most serious incidents we know of occurred in British Columbia when deep, fresh snow ploughed into berms along the railroad caused the caribou to run along the tracks in front of an oncoming train (K. Child, pers. comm.). The firm footing offered by the railroad track, and the high berms acting as barriers, probably contributed to this behaviour.

The presence of transportation corridors also affects caribou by increasing the level of human activity in otherwise remote areas. Access roads invite legal and illegal hunting, and increase the possibility of intentional or unintentional disturbance.

The potential effects of disturbance on wildlife have been discussed by Geist (1978) and Klein (1980). Disturbance elevates energetic costs. If those costs cannot be met by increasing forage intake, they may result in reduced allocation of energy to other requirements, such as growth, reproduction, and escape from predators (Klein 1980). According to Geist (1978), Russian studies show that a high level of unrest among domestic

reindeer (Rangifer tarandus tarandus) leads to increased abortion and resorption of fetuses, excessive weight loss in adults, and increased frequency of disease. Harassment can cause death, illness or reduced reproduction due to the secondary effects of physical exertion or panic. For example, reindeer exerted in cold weather have suffered lung damage, and newborn calves have been trampled or deserted when herds panic (Zhigunov (editor) 1961). Disturbance may also result in avoidance or abandonment of ranges and loss of migratory traditions, as reported for reindeer by Klein (1971, 1980).

Fire affects caribou by returning the forest habitat to an early successional state, thus altering its forage and cover values. Where caribou feed on arboreal lichens, fires have a negative impact on habitat value that lasts for many years; where terrestrial forage is more important, the short-term negative effects are probably offset by beneficial effects in the long term (Section 3.1). Because caribou frequent mature, lichen-bearing forests during some seasons in much of the study area, it would be relevant to examine fire history at least as far back as 150 years. Unfortunately, the available information was limited to fires occurring since about 1940, except where earlier fires were mentioned in the literature.

The most important way in which insect attacks affect caribou is an indirect one: they intensify forest harvesting. Spruce beetle and mountain pine beetle are epidemic in parts of the study area, and forest managers are under pressure to salvage the attacked timber before it becomes unmerchantable. Insect attacks are causing concentrations of logging activity in areas that might otherwise be unlogged, or less heavily logged, at this time. The threat of beetle attack also influences the choice of harvesting systems. Because windfallen trees are a breeding-ground for spruce beetles (Safranyik 1981), managers may be especially reluctant to leave mature timber reserves, or to use any logging prescription that increases the risk of windthrow.

Insect attacks may also affect caribou directly by altering forest structure. Spruce beetles preferentially attack mature and overmature trees; their larvae kill the hosts by girdling them. Blowdown, large-diameter slash, and high stumps are also breeding grounds for bark beetles, and are believed to contribute to epidemics (R. Hodgkinson, pers. comm.). Effects of spruce

beetle include disproportionately greater mortality of the larger diameter (over 30 cm) trees, and increased resistance and survival of smaller trees. Dead trees may remain standing for many years. Although fuel loading increases, there is no evidence to indicate a significant increase in incidence of fire following outbreaks (Safranyik 1981). Mountain pine beetles, in contrast, have a less pronounced preference for older trees, and do not breed in blowdown or slash. Lodgepole pine, the usual host within caribou ranges, commonly grows in even-aged monocultures. For those reasons, mountain pine beetle attacks are more likely than spruce beetle attacks to result in the mortality of the entire stand, or a great part of it.

The direct impact of forest insect infestations on caribou depends on the amount of mortality in the stand, and on the ecological functions of the stand for caribou. Partial mortality in the overstory -- the most common result of spruce beetle attacks -- increases light penetration to the understory and within the canopy itself. Increased light penetration typically results in increased productivity of understory forage (Bunnell and Eastman 1976). On most sites, the additional solar radiation is likely to increase lichen productivity on the residual live trees and on the newly created snags. As the snags age and lose their bark and branches, lichen litterfall increases at the expense of standing crop on the dead trees. Whether or not net standing crop would decline at that time would depend on lichen development on the residual live trees. In the case of severe mortality in the overstory, a decline in net arboreal lichen abundance seems likely once the snags have lost their limbs and bark.

As well as affecting forage availability, beetle outbreaks may affect caribou by reducing the ability of affected stands to offer cover, especially through snow interception. Also, overstory mortality could eventually result in a tangle of fallen snags which could impede movement.

In addition to logging and transportation corridors, a variety of other human developments can have impacts on caribou. Mineral exploration and mining affect caribou mainly by increasing access roads and human activity in remote areas, although large operations may result in habitat alienation. Because seismic lines are often usable by offroad vehicles, they can have the effect of access roads, and they offer a line-of-sight for hunting. Utility corridors, such as pipelines and transmission lines, may function in the same

way. Reservoirs can flood important habitats and can block movement routes. Although caribou are capable swimmers, ice shelves -- either naturally occurring or caused by winter drawdown -- and floating debris can be obstacles to movement.

Recreational activities, including all-terrain vehicle use, snowmobiling, hiking, and heliskiing, can cause harassment of caribou. Stelfox and Bindernagel (1978), describing the behaviour of caribou disturbed by hikers in Jasper National Park, noted that cow-calf groups were especially intolerant of humans, and speculated that encounters with humans could result in increased calf mortality. The general effects of harassment on caribou, described above in relation to roads and railways, may apply also to wilderness recreation.

Winter recreation may also have an indirect effect on caribou by increasing the mobility of predators. Bergerud (1978) described an instance in which a wolf pack, which had been restricted to the valley bottom by five miles of soft snow, followed his snowshoe trail to the windswept mountain top, where they "found the caribou." Snowmobile tracks could have the same effect.

2.1.3 Forest management planning and caribou

The demand to harvest timber within a given area of caribou habitat is related to a number of factors, such as timber quality, species profile, anticipated logging costs, and licensee distribution. Those factors are mainly local in character, and difficult to compare systematically. Harvesting demand is also related to the overall timber supply situation in the TSA in which the caribou habitat is located. TSA's are geographical units established by the Ministry of Forests for analysing, planning and managing forest, range and recreation resources. Ministry of Forests policy requires that TSA planners develop plans that are consistent with the programs and priorities of the Ministry's provincial Five-Year Program, and that give due consideration to other resource values (B.C. Ministry of Forests 1982p). Because Ministry of Forests planners have analysed the timber supply in all TSA's, it is possible to systematically compare the timber supply in TSA's that support caribou (Table 1).

In most of the province, some degree of "falldown" in the timber supply is projected. Because second-growth forests will be harvested at a much younger age than old-growth forests, they will yield a lower volume of timber per

TABLE 1. Timber supply data in the TSA's that support caribou. Twenty-year supply assessments from TSA Yield Analysis Reports; Long Run Sustainable Yield (LRSY) and Allowable Annual Cut (AAC) from B.C. Ministry of Forests (1983).

TSA	20-year supply adequate?	LRSY (m ³ /yr)	AAC (m ³ /yr)	LRSY/ AAC
Kamloops	yes	2261800	2350000	0.96
Okanagan	no	2412400	2700000	0.89
Kootenay Lake	yes ^a	816200	900000	0.91
Cranbrook	no	926000	900000	1.03
Arrow	no	645200	619000	1.04
Revelstoke	yes	114400	130000	0.88
Golden	yes	452500	650000	0.70
Williams Lake	yes ^b	2545400	2500000	1.02
Quesnel	yes	2593600	2300000	1.13
100 Mile House	yes	1349700	1250000	1.08
Lakes	no	1373400	1500000	0.92
Morice	yes	1534900	2000000	0.77
Bulkley	yes	621500	650000	0.96
McBride	yes	486100	500000	0.97
Prince George	yes ^c	8202400	8605000	0.95
Peace	yes	1900000	2000000	0.95

^aShort-term commitment for TSA can be met by making up the shortfall in the Creston PSYU from the surplus in the Lardeau PSYU

^bThe 20-year supply can be considered adequate, despite the removal of the three western blocks, because of the accelerated logging of cedar and hemlock (H. Giles, pers. comm.)

^cThe TSA boundaries have been redrawn to exclude the Morkill drainage since this assessment was made

hectare than do old-growth stands. Foresters hope to minimize the falldown effect through such measures as restocking understocked land, using problem forest types, improving milling technology to increase utilization, and practising intensive forestry (fertilization, thinning, planting genetically superior stock, etc.). Those measures will be most effective in TSA's in which the anticipated falldown is far in the future, and is not severe.

Many TSA's face special long-term supply problems, short-term supply problems, or both. Where falldown is expected to occur early or to be great in magnitude, there is pressure to get the land into a productive state as quickly as possible. There may be extra pressure to harvest problem forest types that are valuable to caribou, such as subalpine fir and cedar/hemlock, in order to stock the land with young trees. There is likely to be resistance to any harvesting methods thought to have extra silvicultural costs, such as selective logging. In TSA's with short-term supply problems, there is pressure to harvest as much as possible of the available timber in order to meet commitments to industry. Special measures, such as exceeding normal cut/leave ratios or accelerating second-pass harvesting, may be considered.

2.2 Kamloops Forest Region - Fish and Wildlife Region 3

2.2.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Maps 4a, 5a, 6a, 7a): Caribou are distributed throughout Wells Gray Park, from the Region 7 boundary south to Foghorn and Harp Mountains and the Bischoff Lakes area and along the Region 4 boundary from McNaughton Lake to Highway 1, east of Anstey Arm.

Historic changes in distribution: According to the journals of George Dawson, caribou were once present in the Silwhorakun Mountain area, between Kamloops and Bonaparte Lake, but became extinct in the mid-1800's (R. Travers, pers. comm.).

Caribou were plentiful through the 1920's in the Hunters Range, along the Region 8 border (S. Macdonald, pers. comm.). On the door of an old cabin on Mara Mountain, a sighting of 98 caribou is recorded. A few isolated observations have been reported in recent times.

On Groundhog Mountain west of Tumtum Lake, the Forest Service lookout regularly observed approximately 30 caribou every summer. After Finn Creek was logged, only a few caribou were seen in the area, but larger numbers were reported during winter in logging slash about 40 km to the south, around Bischoff Lakes. It is unclear whether this represents a change in distribution, and if so, whether it was caused by habitat alteration (S. Macdonald, pers. comm.).

Numbers, status and management

Of the caribou in the present study area, those in the northern portions of Region 3 have been exposed to the greatest continuity of management activity, and are probably the best known. The species has been a high priority in Region 3 for nearly three decades, starting with the Edwards/Ritcey research of the mid- to late fifties (see Section 2.2.4) and continuing since that time with regular inventory (Ritcey 1970, Ritcey and Low 1975, Ritcey 1980, 1982), intensive harvest management (Ritcey 1976), and strong representations for habitat protection (Ritcey 1974, 1979). Data on aspects of the Region 3 animals' population dynamics and status have been kept up to date and were summarized in Ritcey (1976).

One of the most important ingredients in the management process is the ability to detect or recognize changes in numbers. On the assumption that the caribou of Wells Gray Park and vicinity do indeed constitute the population(s) managers "know best" in southern British Columbia, an important consideration in this review is whether the knowledge in that area is adequate.

For Region 3 prior to the mid-sixties, population estimates and trends were determined primarily by synthesizing series of opportunistic observations. Edwards (1954, 1956) supplemented data he gathered on a few field excursions with observations of guides, trappers and other outdoor contacts to document a.) a general pattern of population decrease "by 1935", b.) a period "after 1945" during which the animals "were especially scarce", followed by c.) "an apparent increase after 1952". Winter severity was tentatively suggested as a major factor influencing numbers, although an extensive forest fire in 1926 was also thought to have had a significant negative effect. Bergerud (1978) argued that the 1930's decline and 1940's

low were due to "increased predation following changes in the abundance of prey and predators in early forest seral stages following the fire."

We have few specific numbers for the period before 1960. The largest group reported by Ritcey (1952) was 27 animals seen in the fall of 1951 in the Murtle Lake area, with the implication that there were more in other unsearched areas of Wells Gray Park at the same time. Virtually all the reported caribou observations from the early years were in the park, as were estimates of population size. Ritcey (1955) acknowledged the difficulty of determining abundance in the park with evidence then in hand. Sightings in the years 1951-54 totaled 24, 9, 15 and 13 animals, respectively. A 1955 estimate for the Wells Gray population was 220 (range 85-355). That estimate was the sum of 6 sub-area estimates with subjective "reliability" ratings of good (1), fair (3), and poor (2). The "good" rating was applied to the Battle-Table Mountain area, where an estimate of 35 ± 15 applied.

For the remaining years, as with other regions, there are scattered observations for various locations in Region 3. However, unlike the other regions, there has also been a series of more systematic censuses, i.e., attempts to locate, count and classify the animals over most of the Wells Gray Park vicinity within a short time period. Table 2 lists features and results of the six major surveys which have been undertaken since 1964.

In the following accounts of caribou status by management unit, the census efforts and results from Table 2, where applicable, will constitute a major focus. The area-specific summer and winter population estimates and harvest status information through 1975 are from Ritcey (1976):

1. GMU's 8-23, 8-24, 8-25 (Okanagan Region, formerly units 3-23, 24, 25): Summer and winter populations both estimated at 45 ± 15 .

The estimates imply a resident population in the area, and that may now be the case although movements across the Columbia to and from the east were known in the past, and connections with populations in the north are possible, especially with ones in GMU's 4-38 and 4-39. There have apparently been no attempts at census. The largest groups recorded in the area have been 27 in Monashee Park in August 1966 and 22 about 10 km northeast of the park in August 1973. Officially, there have been only three observations since 1973,

TABLE 2. Features and results of caribou censuses in the Wells Gray Park area, British Columbia, 1964-1982. Figures in parentheses include animals seen outside the park; flight times with asterisks are approximations. Data from B.C. Fish and Wildlife files, Kamloops, B.C.

Survey dates	No. Caribou	Survey features		
		Aircraft	Duration	Conditions
27-28 July '64	148	Super Cub	8.5	Clear and sunny (Ritcey 1964)
13 July '65	61	Bell G2	9.5	"Weather conditions extremely poor" (Ritcey 1980)
15 July '70	308	Bell 206	9.0	"Very favourable weather pattern" (Ritcey and Low 1975)
23-24 July and 13 Aug '75	97(123)	Bell 206	12.8*	Cold June, with poor snowmelt, believed "mainly responsible for ... decrease in number of animals seen" (Ritcey and Low 1975)
24-26 July '80	69(79)	Bell 206	11.8*	Weather conditions "only fair" for survey (Ritcey 1980)
29-30 July '82	64(74)	Bell 206	7.9	Partial survey only, because of deteriorating weather conditions (Ritcey 1982)

none larger than 3 animals, and only "sign" has been recorded in writing since 1977 (Vol. 2, Appendix 1, Region 8). Anecdotal evidence from provincial park staff indicates that observations of caribou by Monashee Park visitors have continued on a regular basis up to the present, but the details of such sightings have not been recorded. Although it appears that caribou still frequent the area, the 1976 estimate of 45 animals is now considered "probably optimistic" because it was based on reports that were never substantiated (R. Ritcey, pers. comm.). The more recent status is uncertain. Some decline from historic levels is likely if, as has been reported, a migration route across the Columbia at Wigwam was terminated by flooding of the river above Castlegar.

There is no hunting season for caribou in that area of the Monashees at present. The closure in GMU's 8-24 and 25 was instituted in 1975 and that in 8-23 the following year. Adjacent units with a history of caribou occurrence had been closed previously (3-34: 1968, 4-14: 1956, 4-32: 1972). Reported harvests in the area had been low prior to closure, averaging just two animals per year between 1964 and 1975, and with no reported kill in 7 of those 12 years (see Table 1 in Ritcey 1976).

2. GMU 3-34: Summer population 0; winter 20 ± 20 .

A resident population is neither implied nor likely, and affinities of any animals occurring there must be the same as those discussed for 8-23, 24, and 25 (above). There are no observations in Appendix 1, Region 3 (Vol. 2) specific to this area and, as noted in the previous discussion, there has been a hunting closure there since 1968.

3. GMU 3-35: Summer population 20 ± 10 ; winter "?". GMU 3-36: Summer population 40 ± 20 ; winter "?".

These units are discussed together because they are adjacent and most observations have been near their common boundary. Although the estimates suggest summer occurrence (i.e., animals that exist separate from those involved in the Wells Gray census figures), most of the few observations available to us are from winter (see Vol. 2, Appendix 1, Region 3). We have

record of only one summer observation from each unit, a single animal at North Queest Mountain (near the boundary between 3-35 and 3-36) in June 1977, and four at the headwaters of Cotton Creek (3-36) in summer 1979. The largest winter groups observed in both units were in 1975, 13 seen at Upper Ratchford Lakes (3-36) on 5 February of that year, and 14 at Rocky Creek (33 km south, in 3-35) on 6 March. Possibly the same animals were involved in both sightings. From 1975 through 1983, the largest groups seen in both units have ranged from two to six animals, and those were observed in winter. The source of caribou on seasonal ranges in the two units is not known, but they are probably not resident there. It seems at least as likely that they come from adjoining units in Region 4 as from more regularly occupied units to the north in Region 3.

An open season for caribou bulls was maintained in 3-35 and 3-36 through the fall of 1978. In 1975, the first year during which the two units existed as separate entities, the actual reported kill applicable to each is unclear but it appears that a total of four was estimated for the units comprising "North Thompson/Adams/Shuswap" (Ritcey 1976). Hunter sample records for the remaining 3 years of open season are as follows:

Year	No. kills estimated	
	GMU 3-35	GMU 3-36
1976	0	0
1977	0	2
1978	1	0

These records tend to confirm the relative unimportance of the two units as summer/fall caribou range. However, it should be noted that the Hunter Sample records are not completely reliable for small areas with low hunter effort. In 1978, the first year of compulsory inspection for caribou, two animals were examined from 3-35 and one from 3-36, a total of three times the Hunter Sample estimate for the two units.

4. GMU 3-37: Summer and winter estimates listed only as "occasional".

There are apparently few known occurrences in the unit and we have no records. This suggests either that the affinities of the animals in 3-35 and 3-36 are primarily to the east (Region 4) or that movement routes to those units from occupied ranges to the northwest is not direct. The area within the unit has not been open to hunting since 1975, and we are aware of no kills specifically attributable to it.

5. GMU 3-40: Summer population 20 ± 10 ; winter 80 ± 30

At least some of the animals tallied within the "Battle/Raft" zone of the summer census area were presumably in this unit, and serve as some support for the summer estimate. Winter observations have been fairly common, especially just south of the park boundary, in the Trophy Mountain area. The largest total was apparently 34 in March 1972, while the largest since then was seven counted both in March 1977 and January 1980 (Vol. 2, Appendix 1, Region 3)¹. It is likely that animals that occur in 3-40 in any season, but especially in winter, are at least occasionally in Wells Gray Park. The radio-collared animal from this area in Antifeau's (1980) study was later contacted at four locations in the park.

The history of hunting seasons for the specific unit 3-40 parallels that of 3-35 and 3-36, closing after the 1978 season. Hunter sample estimates indicate no kills in 1976, two in 1977, and again none in 1978, and in this case there is no disagreement with compulsory inspection data.

6. GMU's 3-41 and 3-42: Summer population 40 ± 20 ; winter 20 ± 10 .

We are aware of no specific summer sightings and few observations overall, especially in 3-41. In 3-42 there were apparently repeated sightings of caribou in logging areas near Tumtum Lake in winters throughout the late

¹T. Antifeau (pers. comm.) reported estimates of up to 17 caribou for the area, based on combined sightings of both animals and tracks, on 1 November 1978 and again on 21 January 1980.

1970's, with a high count of 25 in two groups in the Groundhog Mountain area on 18 March 1979.¹ Again, it is possible that animals which occur in these units are shared both with Region 4 to the east and the more regularly-used (Wells Gray) units to the west. However, as pointed out by R. Ritcey (pers. comm.), there have been no recent reports of animals crossing Highway 5.

As with 3-37, these units have been closed to caribou hunting since they were established in 1975. However, some illegal hunting has been documented, with two animals reportedly killed in 3-42 in 1979.

7. GMU 3-43: Summer population 20 $\pm$ 10; winter 40 $\pm$ 10.

The estimates imply that the winter status is more certainly known (smaller limits in relation to the estimate), but supporting data are not evident among our records (Vol. 2, Appendix 1, Region 3). We know of only one winter sighting, that of eight animals near the headwaters of Robina Creek (at the Region 7 boundary) on 27 March 1979. However, tracks were seen in a cutblock at lower Clemina Creek in March 1980 (T. Antifeau, pers. comm.). In the 1980 census flight, there were two sightings of caribou in the unit, including four at Mount Cheadle and four others a few kilometres south in the Bone Creek drainage. Animals in 3-43 could have affinities with ranges in Region 7 to the north and Region 4 to the east, as well as to the regularly occupied Region 3 ranges to the west.

The unit has not been an important area for caribou harvest, although it was one of two that remained open to hunting through the 1982 season. Hunter sample data show no kills in the years 1976-1978, and compulsory inspection records list none between 1978 and 1982.

8. GMU 3-44: Summer population 50 $\pm$ 20; winter 50 $\pm$ 20.

The estimates indicate continuous occupancy by caribou, if not resident status. In all respects, this appears to be the most important unit to caribou outside of Wells Gray Park and it is likely, given its location, that

¹Based on sightings and track counts, T. Antifeau (pers. comm.) estimated that there were up to 39, in three groups, in that area on 5 March 1980.

most of the animals occurring there are shared with the park. This unit was not covered in the 1970 summer census, so did not contribute to the peak total obtained in that year. In the 1975 census, nine observations totalling 26 animals (21% of all seen) were recorded in 3-44, while in 1980 none of 79 and in 1982 two of 74 were seen in that unit. The area of coverage within 3-44 differed in those years (R. Ritcey pers. comm.). In the years since 1975 our records indicate several sightings in all seasons, but mostly in numbers less than 10.

As with the previous unit, 3-44 remained open for hunting through 1982. It produced only one reported kill in the years 1976 through 1981, although three were apparently taken in 1982 (compulsory inspection data). It was, in 1982, the only unit in Region 3 that supplied a legal harvest of caribou.

9. GMU's 3-45 and 3-46 (Wells Gray Park): Summer population 350±100; winter - "?".

The park is clearly the core of caribou occurrence in Region 3. It is probably the ultimate source of animals seen in most adjoining units, as outlined above. It has been the site of most of the earlier local research, and has been the primary area involved in the intensive census efforts alluded to earlier. In short, most reference to caribou in Region 3 is to "the Wells Gray herd".

The census flights have been done in summer, based on an observed tendency of the animals to seek relief from heat and/or insects by moving onto or near snow patches at high elevation. A survey from a small fixed-wing aircraft in late July 1964 tallied 148 caribou, mostly above 2500 m, while another by helicopter in mid-July 1965 found only 61 animals, and those were distributed between 1525 m and 2075 m. The observed differences between those two surveys in the distribution of animals, and therefore also in the counts, were likely due to weather effects (Ritcey 1970).

In 1970 a fortuitous blend of weather, animal distribution, budget and timing resulted in a count of 308 animals in the main park count and a minimum of 30 others in adjacent areas a few days later. The total of 338 was believed to represent "at least 75% of the park population" (Ritcey 1970), considering the proportion of the total area covered and the "expected"

distribution of the animals. The latter was supported by some reconnaissance at lower elevations. A projection of 350-400 animals was therefore generated as a baseline figure for the summer population of Wells Gray Park. An additional 235 (± 105) were estimated to occur in summer in the remainder of Region 3 caribou range (Ritcey 1976), but those estimates are apparently based mostly upon professional judgment and chance observations, scattered in time, rather than on the surveys.

On the planned schedule of one park survey every 5 years there have been two more counts since the baseline 1970 effort. Neither came close to the 1970 total (123 in 1975, including about 22 animals in areas not covered in previous surveys, and 79 in 1980). Again, the relatively low count in 1975 was felt to be largely a result of unfavourable weather prior to the survey (Ritcey and Low 1975). That is, under the circumstances, a count which was less than 40% of the previous figure nevertheless could not adequately attest that there had been a population change. The 1980 census was also carried out under weather conditions that were less than ideal, both before and during the counts, but in that case a variety of factors prompted the observer to conclude that "... there has been a significant decline in caribou numbers in the past ten years" (Ritcey 1980). Two factors listed were smaller group sizes and smaller numbers in all areas surveyed in 1980.

Hatler (1983:62) expressed the opinion that "... every species has a particular set of circumstances (time/place/weather) under which it will be most vulnerable to being counted, i.e. when the highest proportion of its local members will be occupying habitats in which they are most readily seen." One of the objectives in his studies in northern British Columbia is to attempt to define those circumstances through repeated contacts with collared animals over several annual cycles. The Region 3 summer snow patch surveys represent an empirical assessment of relative caribou conspicuousness in that area. That it has potential is illustrated by the 1970 results. However, with its dependence upon particular weather conditions it is also risky, a fact illustrated in census attempts subsequent to 1970. Both Ritcey (1976) and Bergerud (1978) have acknowledged and discussed the problems involved.

The summer snow patch system may be the best census technique for the southern mountains of British Columbia, but that is not determinable without

more systematic observations. Whether it is or not, it is evident that greater flexibility in scheduling is required. Rigid adherence to a once in "x" years program risks by-passing the summers with most favourable survey conditions and conducting surveys when conditions are poor. Further, when one obtains a poor count such as that of 1975, it does not seem prudent to wait 5 years to attempt to determine whether results were real or an artifact of survey conditions. Ritcey (1976) has essentially made these points previously.

Fortunately, the Region 3 observations were not held to the once-each-five-years schedule. The most recent major census effort was in summer 1982. That survey was again hampered by weather, to the extent that only a portion of the area could be surveyed. A total of 76 animals was counted, as compared to 40 in the area of comparable coverage in 1980. That comparison led to a conclusion that numbers had attained "a significant increase" since 1980, although remaining at little more than half that recorded in the peak 1970 count (Ritcey 1982). It is not clear why the observed result could not be interpreted as evidence that the decline suspected in 1980 was not as great as had been thought. High potential recruitment in 1980 (calf ratio of 27%) is cited as the primary evidence in support of increase to 1982, but high calf ratios (18-20%) and little documentable mortality have been the rule in the area throughout the 1970's. Indeed, as shown by Ritcey (1976), the potential recruitment (summer calf ratios) it is not known to have changed dramatically since at least the early sixties, although mortality, especially that due to hunting, was highest in the 5 years preceding the peak in 1970.

An important question arising from consideration of the 1982 survey is whether or not partial surveys may serve as samples for local population projections. If the caribou were homogeneously or at least predictably distributed, such manipulations would seem permissible. However, the animals tend to occur in groups of varying sizes and there is as yet no certain evidence that individuals or groups are tied to any particular place at survey time. That is, with no change in numbers, animals counted in Area "A" on one survey may be in Area "B" on the next. If Area B is not counted, an erroneous interpretation of decline will be made and if only Area B is counted, the interpretation (also in error) will be that an increase has occurred.

Table III in Ritcey (1982) lists counts in 13 regularly covered survey sub-units over the four surveys since 1970. To assess the apparent predictability of those areas in terms of their individual contributions to the total counts prior to 1982, we converted the individual counts for 1970, 1975, and 1980 to a percentage of total count for those years. For example, 5.8% of all caribou seen in the 1970 census were in the "Mobley-Anderson" sub-unit, while in 1975 and 1980 the comparable percentages were 1.6 and 0, respectively. The mean percentage attributable to that sub-unit over the three surveys was 2.5%, with a standard deviation (SD) of 3.0. Analyzing all 13 sub-units similarly, we found that 12 had SD's that were 50% or more of their respective means and for eight of the 12, the SD was actually larger than the mean. The variability in these data suggest the need for caution in interpreting results from partial surveys.

In the above context, it is not clear just what would constitute a "complete" survey in Region 3. Indeed, the jurisdictional considerations of administrative boundaries (regional, parks, management units) may be an important negative influence in the inventory and management of caribou throughout the present study area. The most significant aspect of the 1982 survey was that it was to have included simultaneous surveys in adjacent areas of Regions 5 and 7, as well as in the usual areas of Wells Gray Park and the rest of Region 3 caribou range. It is likely that the Wells Gray Park population actually has affinities over all of those areas and it is possible that the 300+ animals seen in the park in 1970 represented an unusual grouping of animals from one or more of them rather than simply "park baseline".

The lack of knowledge about winter occurrence in the park is a serious deficiency. If, as is feared, the major wintering areas are elsewhere, then the park and its "conservancies" offer little real security for caribou. Considered in that light, the decline suspected as a result of comparing the 1970 and 1980 census figure could be a continuing reality.

As shown in Table I of Ritcey (1976), the recorded harvest for the park between 1964 and 1969 (the years immediately prior to the highest count in 1970) ranged from 24 to 36 annually, with a mean for that period of 31. From 1970 to 1975 the park kill declined, apparently primarily in response to more restrictive regulations, from 19 to two, with a mean for that period of 11.

Hunter sample estimates indicate only four additional kills from 1976 through 1981, two each in 1976 and 1977 and all in GMU 3-46.

The history of hunting regulations in Wells Gray Park shows a progression from the most liberal in the province to complete closure. An extensive closure over much of the province in the 1940's and 1950's included what is now Region 3. In 1955-56 caribou hunting was re-opened in the park with an either-sex season lasting 3.5 months. It was the first open season for females in the province since institution of a bulls-only regulation in 1914 (Vol. 2, Appendix 4). Either-sex seasons of 86 or more days duration persisted through 1972. In 1973, the 86-day season pertained for males, but that for females was reduced by more than a month. The either-sex regulation was dropped in 1974, and the season for males began shortening -- to 72 days in that and the following year, and down to 30 days by 1976. In 1977 GMU 3-45 was closed to all caribou hunting. In the remainder of the park (3-46), the season was cut still shorter, to 24 days, a season that persisted until 1980 when that unit was closed.

Interestingly, the highest count on record (1970) was obtained after a period of 15 years of liberal, either-sex hunting. Population trend during that period can not be documented, but Ritcey (1970, 1980) has continually affirmed that observed harvest was insufficient to have caused a decline. He also points out (1976, 1980) that the trend to declining harvest in the 1970's was primarily a result of the ever-tightening restrictions during that decade. The culmination of restrictions in total closure came during, and in spite of, continued high calf ratios and decreasing documented mortality.

Concluding comments: Prior to the 1982 survey, the status of Region 3 caribou (from Ritcey 1980) was believed to be "significantly less" than the mid-decade mean estimate of 585 (Ritcey 1976), and possibly (still) declining. The 1982 survey gave some support to renewed optimism. However, even if increasing, the park population was still considered to be only about half of that extant in 1976, and that was possibly true for the regional population (R. Ritcey, pers. comm.). Despite the long history of contact with Region 3 caribou, the status statements could be no more certain. Further, despite the existence of actual census information for at least parts of the region in some years, there is a considerable subjective component even in the figure (585) considered to be the recent baseline estimate. That is, the mean

estimates and associated "confidence limits" presented in Ritcey (1976) were not generated by statistical methods.

Clearly, the subjective impressions of Ritcey, based on his familiarity with the area and local experience with the animals over more than 30 years, add a dimension to the data that can not be improved upon by an outsider. The point here is not to refute his claim that Region 3 caribou declined in the 1970's, but to argue that there is insufficient evidence to either confirm or quantify it, let alone to identify its causes. A controversy regarding causes has nevertheless developed. Bergerud (1978) accepted the conclusion of decline and invoked predation to explain it. Ritcey (1976, 1982) presented arguments contrary to the predation hypothesis, dismissed legal hunting mortality (though wondering about the extent of poaching), and speculated on the negative effects of habitat loss. In the end, more intensive observations are required. Logically, these would be to determine, first, whether the population trend is down, and then both how and why. The most serious consideration at this point is whether there is still time to follow that logical sequence.

2.2.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Maps 4a, 5a, 6a, 7a): Most ranges are well known, but winter ranges in Wells Gray Park are poorly known, because there have been few winter flights over the park. The northern and northeastern parts of the region are poorly known. No suspected wintering area has been located on the Hunters Range. Most winter ranges are medium to poor forest sites in spruce-balsam or balsam-spruce of age class 8 or 9 at 1500-1800 m (Ritcey 1976). Arboreal lichens are the major late winter forage on high-elevation ranges (Edwards and Ritcey 1960; Miller 1977; Antifeau 1980; B.C. Ministry of Environment 1981). Caribou have also been observed browsing and cratering in soft snow during this season, usually when travelling through low-elevation forests (T. Antifeau, pers. comm.). They may feed on exposed alpine vegetation when it becomes available in late March and April (Antifeau 1980).

Spring: Edwards and Ritcey (1959) reported that caribou use lowland forests in spring. Antifeau (1980) found that during the last week of April 1979, all four collared caribou moved from subalpine habitats to mature timber on middle or lower side slopes. Food habits have not been documented for this period, but young spring vegetation is probably used.

Calving areas: Little is known. R. Ritcey (pers. comm.) does not believe that there are special calving areas.

Summer: Summer ranges are fairly well known. Caribou use mature spruce-balsam forests, subalpine parkland, and alpine meadows, often adjacent to small lakes and bogs (Antifeau 1980). They concentrate on snow patches during hot weather in July and August. Edwards and Ritcey (1960) reported use of lichens, mosses, grasses and sedges, and the forbs Pedicularis groenlandica, Erythronium grandiflorum, and Valeriana spp. during the period May-August.

Rutting areas: No specific rutting areas are known. Animals monitored by Antifeau (1980) were in alpine and subalpine areas during the rut. In some years, snow forces rutting groups to lower elevations (R. Ritcey, pers. comm.).

Fall/early winter (Vol. 2, Maps 4a, 5a, 6a, 7a): When snow is soft in early winter, caribou use lowland forests with dense canopies (Edwards and Ritchie 1959). As snow accumulated at higher elevations, Antifeau (1980) found that caribou moved from the subalpine to mature timber on middle and lower sidehills. When deep, wet snow was present at all elevations, most caribou remained below 1400 m and did not make major movements. Forage items during this period include grasses and sedges, ferns and horsetails, evergreen herbs and dwarf shrubs (Cornus canadensis, Pachystima myrsinites, Linnaea borealis), tall shrubs (Vaccinium spp., Rosa spp., Salix spp., Ribes spp., and arboreal lichens (Bryoria spp., Alectoria sarmentosa, Lobaria pulmonaria) (Edwards and Ritcey 1960; T. Antifeau pers. comm.). During this period, some caribou congregate around active logging and use arboreal lichens on felled trees (Antifeau 1980).

Movement routes and special habitats: Some movement routes have been mapped (Vol. 2, Maps 4a, 5a, 6a, 7a). Antifeau's work with radio-collared caribou generally supports the migration pattern described by Edwards and Ritcey (1959). However, the movements of the radio-collared animals were more complex and extensive than the pattern described by Edwards and Ritcey. Upslope and downslope movements occurred frequently during winter, apparently in response to changing snow conditions, and major horizontal movements of 10-30 km or more occurred within seasons.

Factors affecting caribou habitat

Logging: A variety of partial cutting systems were used in the Kamloops Region in the 1940's, 1950's, and early 1960's (C. Grove-White, C. Roadhouse, pers. comm.) mostly in low-elevation stands of spruce and subalpine fir. Harvesting in cedar-hemlock stands was limited largely to removal of high-quality cedar, leaving hemlock and less desirable cedar.

Several approaches were used. Diameter limit logging, usually to 11 in. (2 cm) diameter at breast height (DBH), was used from the 1940's through 1965. This was an attempt to achieve natural regeneration and a short rotation, while supplying the mills with large trees. Tree marking was used from the mid-1940's through the mid-1950's. Trees were marked for cutting by foresters on the basis of vigour and susceptibility to windthrow. Seed blocks were sometimes left in the mid-1950's, but many of them blew down soon after logging. Cut and leave strips were used from the mid-1950's to the mid-1960's. Problems with marginal blowdown were common in overmature timber, especially where soils were wet or shallow. By the time close utilization standards were introduced in 1966, significant areas in spruce - subalpine fir stands below about 1500 m had been partially cut or logged to intermediate utilization standards. Unlike some areas, the Kamloops Region retains a number of older blocks with residual timber dating back 20 years or more.

Since 1966, most logging has been patch clearcutting to close utilization standards. The first pass has been completed in most lower-elevation spruce - subalpine fir stands and there is now considerable harvesting above 1500 m. Continuous strip logging was introduced in the late 1970's and has been used sporadically. This system of long narrow clearcuts, parallel to the

contours and separated from one another by narrow leave strips, is intended to minimize ground disturbance by eliminating spur roads and reducing skid distance (J. Robinson, pers. comm.) In some caribou ranges, diameter limit logging to limits ranging from 8 to 14 in. (20.3 to 35.6 cm) has been carried out, in an effort to preserve a lichen-bearing residual stand (Monteith 1979).

Silvicultural practices vary according to stand and site condition. In cedar - hemlock stands, the normal silvicultural procedure is to clearcut, broadcast-burn and plant with spruce. Where slopes are moderate enough for machines, the slash may be windrowed and burned. In spruce - subalpine fir stands, site preparation after clearcutting generally consists of either broadcast-burning or windrowing and burning, and is followed by planting with spruce. Where diameter-limit logging is done in caribou habitat, the residual stand is protected. Where a healthy advance regeneration of subalpine fir exists, it may be protected for silvicultural reasons. Fill-in planting is sometimes required.

A limited amount of stand tending is carried out in subalpine fir thickets on good or medium sites. Stems are generally spaced to 3 or 4 m.

Fragile soils and steep slopes make site preparation more difficult as logging operations move to higher elevations. Brush is a problem in the wet Blue River area; silviculturally, it is desirable to clearcut, burn, and plant immediately to minimize alder competition. The other major silvicultural problem is the large area of good sites occupied by decadent cedar - hemlock (J. Robinson, pers. comm.).

Transportation corridors and access: The largest area without access is Wells Gray Park, where roads are confined to the southern portion. There is a major access road to Clearwater Lake, and there are several roads to the park boundary. Outside the park, all major caribou ranges have access at least to low elevations, and in many cases to high elevations as well. The largest roadless area outside the park is the rugged Monashee Range, which supports few caribou.

Highway 5 poses a collision hazard to caribou between Lempriere and Blue River, where it crosses several traditional migration routes.

Fire history (Vol. 2, Maps 4b, 5b, 6b, 7b): During the late 1920's and 1930's, there were a number of large fires in the southwestern portion of the caribou ranges in the Kamloops Region. Some were confined to lowland forests, but others extended into high elevation timber (R. Ritcey, pers. comm.). Edwards (1954) argued that a major fire in 1926 in lowland forests in the Clearwater drainage, and several subsequent fires, caused the decline of caribou in Wells Gray Park in the 1930's. Fires during that era also affected caribou ranges in the Raft drainage and on mountain slopes between Adams Lake and Seymour Arm (R. Ritcey, pers. comm.)

Other caribou ranges that have been affected by major fires since that time are the Tumtum Lake Range (1950's and 1960's), the Perry Range (1950's), and the upper North Thompson and adjacent areas in Wells Gray Park (1960's and 1970's). Significant fires occurred throughout the park during the 1950's and 1960's.

Insect attack (Vol. 2, Maps 4b, 5b, 6b, 7b): The spruce beetle is currently a less serious problem in the Kamloops Forest Region than elsewhere in the study area. In 1981, the Canadian Forestry Service did not detect any spruce beetle attacks through their aerial surveys, but approximately 6100 ha of infestations were mapped through ground surveys (R. Edward, pers. comm.).

Small spruce beetle infestations are scattered throughout the North Thompson watershed. The largest concentrated area of attack includes the Lempriere, Chappell, Miledge, and parts of the Thunder River drainages. Salvage logging is underway in that area, which includes much of the winter range of the Miledge caribou. Small infestations are scattered through the Raft watershed, and there is an outbreak along the neight of land between Wire Cache and the Adams River. That area is within the range of the Tumtum caribou.

Other developments and human activities: Increased access to high elevations has created harassment problems in some areas. Snowmobiling is a disturbance factor on Trophy and Raft Mountains, and helicopter skiing may become a problem in the future. Regional Fish and Wildlife staff have been unsuccessful in attempts to obtain an all-terrain vehicle closure on Trophy Mountain (R. Ritcey, pers. comm.). Within Wells Gray Park, harassment is not

a major problem as most caribou ranges are remote from heavy use areas (R. Howie, pers. comm.).

Status of habitat in caribou ranges

Winter ranges in the Kamloops Region (Fig. 4) are characterized by a relatively high proportion of immature timber (IM, NSR, and DSD), due to extensive fires and timber harvesting. All the identified winter ranges have been affected by logging except Anstey Ridge, Pettipiece Pass, and the ranges within Wells Gray Park. High-elevation ranges in this region are fairly well known; they include mountains with large proportions of alpine, such as Raft-Trophy, and high plateaus without alpine area, such as Reg Christie (Shannon) Ridge and Avola-Peddie. The low-elevation ranges are poorly known; they were tentatively identified on the basis of the movements of radio-collared caribou (Antifeau 1980) and on reports of repeated observations by loggers. It is possible that some of those areas are not regularly used ranges, but are places that were temporarily attractive to caribou because of the lichens available on logger-felled trees.

The following areas are not included in the Mark IV data base: Pettipiece Pass east of the regional boundary (TFL 23), and caribou ranges in Wells Gray Park.

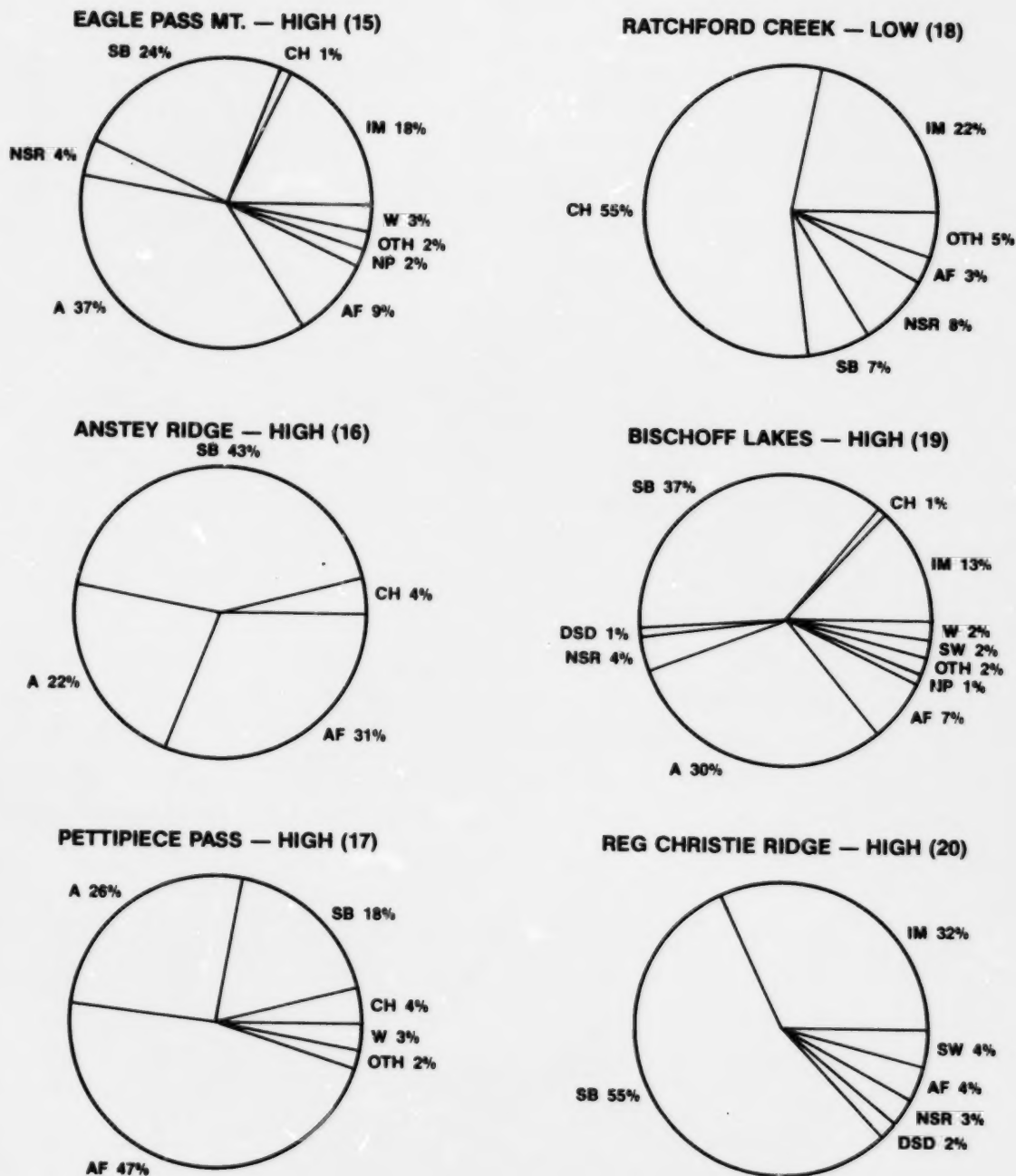
Forest management planning

Most of the caribou ranges in the Kamloops Region are in the Kamloops TSA. The Ratchford Creek and Perry River ranges, as well as any ranges between Highway 1 and the Region 8 boundary, are in the Okanagan TSA.

The Yield Analysis Report for the Kamloops Timber Supply Area (Kamloops Forest Region 1981; revised 1982) indicates that the timber supply is adequate to meet licensees' demands for the next 20 years (Table 1), at which time a slight falldown is anticipated. The Long Run Sustained Yield (LRSY) is approximately 96% of the present Allowable Annual Cut (AAC) (B.C. Ministry of Forests 1983).

The Kamloops TSA Yield Analysis Report examined the implications to the timber supply of four possible options for protecting caribou habitat in the Raft and North Thompson Public Sustained Yield Units (PSYU's), an area roughly equivalent to GMU's 3-40, 41, 43 and 44. Those scenarios were based on

FIGURE 4. Status of habitat in caribou ranges: Region 3.

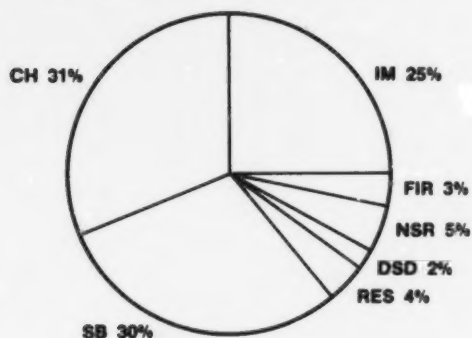


LEGEND			
IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
		W	Water
DEC	Mature deciduous	OR	Open range
RES	Residual	ROC	Rock
NSR	Not sufficiently restocked	OTH	Other

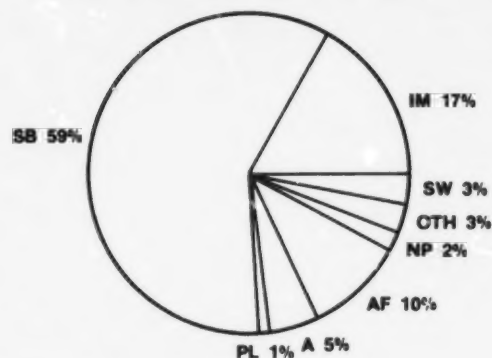
Categories with less than 1% are grouped into OTH

FIGURE 4. Status of habitat in caribou ranges: Region 3 (continued).

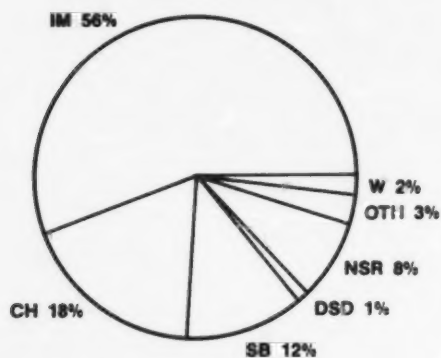
WIRE CACHE SADDLE — LOW (21)



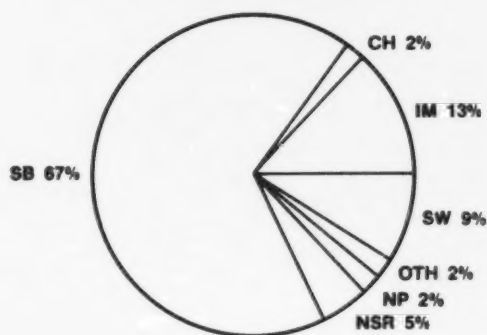
GROUNDHOG MT. — HIGH (24)



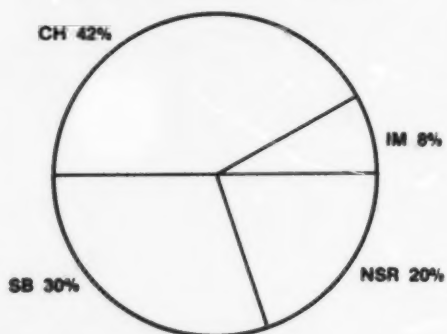
GOLD CREEK — LOW (22)



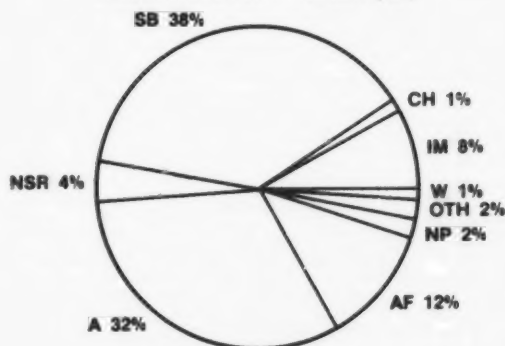
AVOLA-PEDDIE — HIGH (25)



TUMTUM LAKE — LOW (23)



RAFT-TROPHY — HIGH (26)

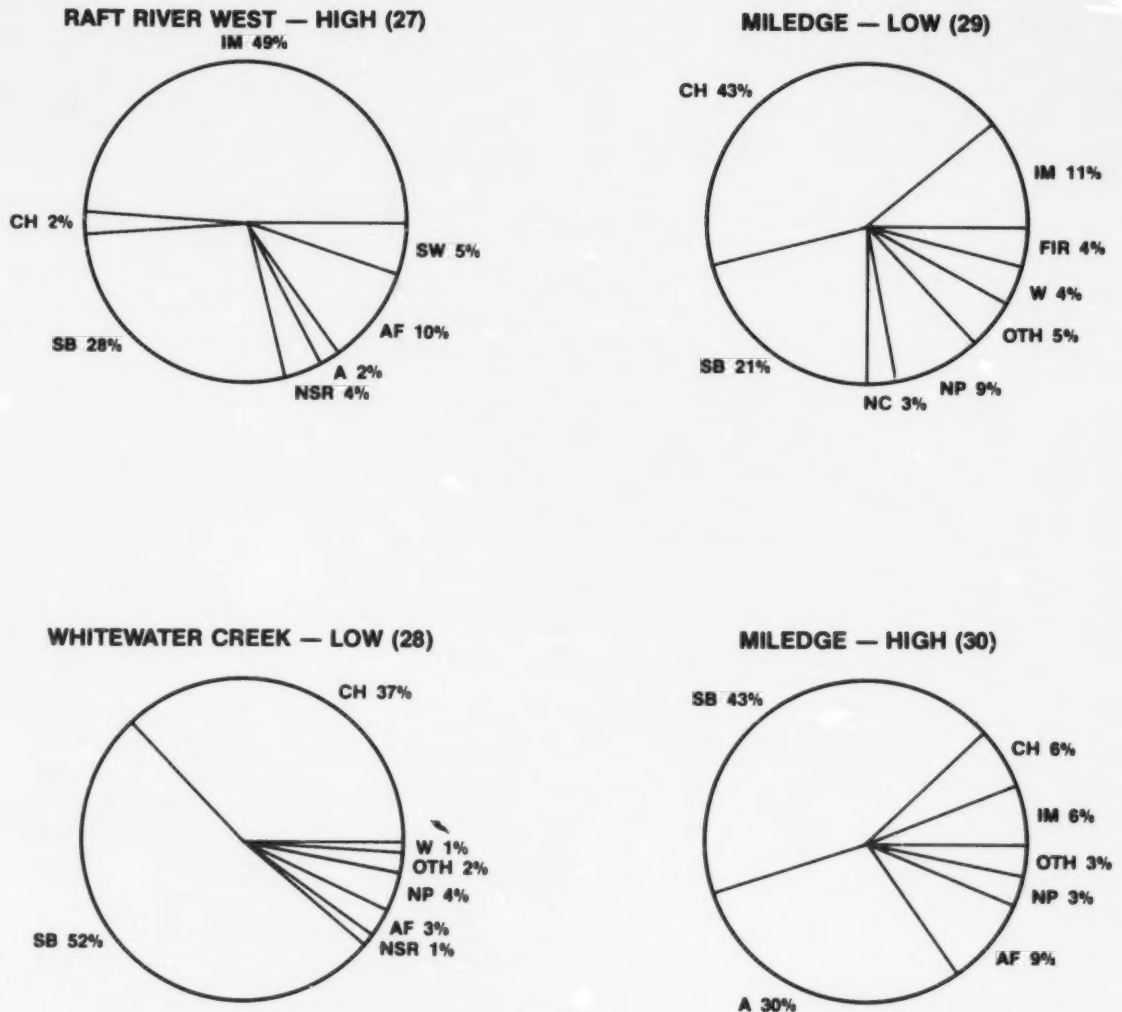


LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

FIGURE 4. Status of habitat in caribou ranges: Region 3 (continued).



LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH



management options identified by the Environment and Land Use Committee (ELUC) Secretariat (1980; B.C. Ministry of Environment 1981). The four scenarios and their impact on the timber supply are summarized in Table 3. The effect of each option on the available mature volume was used to analyze the short-term timber supply (April 1982 analysis). Reductions to the productive land base were used in the long-term analysis.

In the short-term analysis Scenarios 2-4 reduced the net harvest by up to 3.8%. That calculation takes into consideration factors such as accessibility and cut-leave patterns, which reduce the amount of mature timber that can be harvested in the next 20 years. Any one of those scenarios would leave enough timber to accommodate the existing commitment to licensees for the next 20 years, but would adversely affect them by limiting species utilization and operating areas. In the long-term analysis, Scenarios 2-4 resulted in an earlier falldown by 10-20 years, and a drop in the LRSY ranging from 1.9 to 3.8%.

In setting the AAC, the Chief Forester allowed for the deduction of 10 000 ha of important caribou habitat in areas adjacent to Wells Gray Park (AAC Determination, Kamloops TSA, 15 July 1981). That represents a reduction of about 15 000 m³, or 0.6%, of the allowable annual cut of the TSA, and falls between Scenarios 1 and 4 in terms of its impact on caribou and on the timber supply. In addition, logging was to be suspended until 31 December 1982 within a 26 000 ha area important to caribou emigrating from the park, to allow time for further consideration of management options. The Chief Forester did not wish to make further withdrawals without formal confirmation that they were essential to meet caribou management objectives. That situation resulted in the formation of the Caribou-Old Growth Working Group. That task force, with members from the Ministries of Forests and Environment, is to examine the problem in a broader geographical context and to prepare management options for consideration by ELUC.

In the Okanagan TSA, the timber industry faces a short-term supply deficit as well as falldown in the long term. The short-term deficit is due largely to a reduction over the next 10-15 years in timber now being supplied from private lands and from Crown land held under temporary tenure (Crown Zellerbach Canada, Ltd. 1980). In addition, the AAC established in 1980 (AAC Determination, Okanagan TSA, 31 October 1980) represents a reduction by

TABLE 3. Impact of caribou management scenarios on timber supply, Raft and North Thompson PSYU's. Data from Kamloops Forest Region (1981:36).

Scenario	Mature volume reduction (m ³)	Reduction in net harvest (%) ^a	Area reduction (ha)	Reduction in LRSY (%) ^a
1. No special allowance for caribou other than EPA's. ^b	-	-	-	-
2. All range once supporting caribou in Raft and North Thompson PSYU's excluded from harvest.	9 100 500	3.8	45 490	3.8
3. Protection of range for existing caribou populations with provision for a possible future increase.	5 612 500	1.4	26 000	2.4
4. Protection of range vital to caribou that migrate to and from Wells Gray Park.	4 393 500	0.5	20 500	1.9

^aRecalculated on basis of April 1982 revisions to Net Harvestable Short-term Timber and Long Run Sustainable Yield.

^bIn the Raft and North Thompson PSYU's, no Environment Protection Areas (EPA's) were identified specifically for the protection of caribou. Some EPA's identified for other reasons, such as sensitive soils, are also important caribou habitat (M. Monteith, pers. comm.).

7% (200 000 m³) of the 1979 commitment level (Kamloops Forest Region 1979). Falldown to the Long Run Sustained Yield level is anticipated after 30 years. The Long Run Sustained Yield is approximately 89% of the present AAC (B.C. Ministry of Forests 1983) (Table 1).

At present, the concentration of industry activity is in the central and southern portion of the TSA. The northeastern supply blocks, in which caribou occur, have a greater remaining supply of mature timber than the drier parts of the TSA. Although there is no timber supply shortage in those supply blocks at present, there will be heavy pressure on them in the future because of deficits elsewhere in the TSA (Crown Zellerbach, Ltd. 1980; D. Ferguson, pers. comm.).

Habitat protection

East of the North Thompson River, habitat protection for caribou has consisted mainly of modifying harvesting patterns by limiting cutblock size and layout, and by using selective logging techniques. Diameter limit logging, faller's choice, and a combination of these two methods have been used to maintain some mature canopy cover after logging. In addition, migration reserves have been established along some known movement routes (S. Macdonald, pers. comm.).

Habitat protection west of the North Thompson River has been handled differently, due to the proximity of the ranges to the caribou in adjacent Wells Gray Park. That area has been the subject of an ongoing conflict between the Fish and Wildlife Branch (Ministry of Environment) and the Ministry of Forests (Ritcey 1979), as the following chronology indicates:

1969: In its contribution to PSYU planning, the Fish and Wildlife Branch recommended no further logging in important caribou ranges in the Raft and North Thompson PSYU's. That recommendation was not accepted by the Ministry of Forests.

1973: The Fish and Wildlife Branch delineated a moratorium area above 5500 ft (1676 m) and requested no further logging until critical caribou habitat could be defined. The Forest Service rejected that request because it would have too great an effect on the AAC.

1976: The Fish and Wildlife Branch prepared a Regional Caribou Management Plan (Ritcey 1976) which delineated important caribou habitats more precisely, and recommended a cutting plan based on a 250-year rotation. Those proposals were rejected by the Forest Service.

1978: The Fish and Wildlife Branch prepared a proposal that would allow selective logging in 50% of the moratorium area. Following the rejection of that proposal by the Ministry of Forests, the problem was brought to the attention of the Thompson-Okanagan Resource Management Committee, which requested assistance from the Environment and Land Use Technical Committee.

1979: A Steering Committee, chaired by the ELUC Secretariat, was formed to study the caribou-forestry conflict in the Raft and North Thompson PSYU's, and to identify options for its resolution.

1980: The Steering Committee completed its report. ELUC referred the problem to the deputy ministers of the Ministries of Forests and Environment for resolution.

1981: The AAC determination made allowance for the deduction of 10 000 ha of caribou habitat, and the suspension of new logging operations on 26 000 ha until 31 December 1982. The deputy ministers requested that the problem be presented to ELUC in a broader regional context.

1982: A Working Group on Old Growth and Wildlife in the Quesnel-Shuswap Highlands was formed to analyze the problem over a larger area (including portions of the Kamloops, Cariboo, Prince George, and Nelson Forest Regions) and present ELUC with options for resolution.

During the period of conflict, logging has continued within the caribou ranges at issue. In some areas, selective logging has been used in an effort to mitigate the impact of harvesting on caribou. R. Ritcey (pers. comm.) estimated that over 25% of the mature cover has been removed from the original area of concern since 1969.

2.2.3 Information needs

Although most high-elevation ranges in this region have been identified, additional information is needed in a few areas. Low-elevation ranges and movement routes are poorly known, except in areas studied by T. Antifeau. If special calving and rutting areas exist, they are unknown. Although the importance of the Raft-Trophy-Peddie area to Wells Gray Park caribou is clear, more information is needed to assess the importance of the Mileage Creek and upper North Thompson areas to park caribou.

2.2.4 Information base

Aerial surveys

CLI - 82M: 2&3/68, 1&2/70

83D: 12/69, 1&2/70

93A: 1&2/69, 2/71

Fish and Wildlife - 7/11/65, 1/25/65, 3/31/67, 4/3/70,
summer/70, 3/30/72, 3/75, 7/23/75, 8/13/75, 3/2/76,
3/29-31/77, 3/27/79, 7/24-26/80

T. Antifeau - frequent survey flights as part of
radiotelemetry study during period Jan/79 to March/80.

Fish and Wildlife reports on caribou inventory

Ritcey (1952, 1955, 1970, 1980, 1982); Ritcey and Low (1975)

Studies of caribou in Wells Gray Park

Edwards (1954) - Attributed decline in caribou population in
1930's to extensive fires in low-elevation forests.

Edwards (1958) - Characterized British Columbia caribou habitat as
rolling mountains with summits above treeline or elevated
tablelands, usually transitional between plateaus and
precipitous mountains. Based on observations in Wells Gray
Park and four other areas.

Edwards and Ritcey (1959) - Described double migration in which
caribou moved between alpine-subalpine areas in summer,
low-elevation forests in early winter, treeline areas in
late winter, and low-elevation forests again in spring.

Edwards and Ritcey (1960) - Described food habits of Wells Gray Park caribou and noted importance of arboreal lichens in winter. Based on 93 field observations and 13 rumen samples.

Edwards et. al. (1960) - Sampled standing crop of arboreal lichens available to caribou at four sites in Wells Gray Park.

Ahti (1962) - Ecological study of lichens used by caribou.

Miller (1977) - Report on summer ground survey of Wells Gray Park.

Environment and Land Use Committee (ELUC) Secretariat study 1979-80

Objectives: summarize existing information on the forest and caribou resources of the Raft and North Thompson PSYU's, determine the extent of conflict between logging and protection of caribou habitat, and identify options for conflict resolution.

Reports: Dick (1979), ELUC Secretariat (1980), B.C. Ministry of Environment (1981).

T.D. Antifeau, M.Sc. thesis on winter ecology of caribou, in prep.

Major activities: Radio-telemetry, aerial surveys, snow and weather studies, inventory of arboreal lichen standing crop.

Reports: Antifeau (1979, 1980).

K.A. Palmer, arboreal lichen studies

Palmer (1981) - Studied lichen cover on snags in relation to lichen cover on live trees, and identified factors influencing lichen cover on snags.

Palmer 1982 - Studied arboreal lichen abundance in Engelmann spruce - subalpine fir stands 5, 10, 15, and 20 years after partial cutting.

2.3 Kamloops Forest Region - Fish and Wildlife Region 8

2.3.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Map 4a): Caribou are found in the Monashee Mountains from the Region 3 boundary south at least to Sitkum Creek. Region 4 caribou west of Upper Arrow Lake are also discussed in this section.

Historic changes in distribution: Caribou have been greatly reduced or eliminated in the western and southern parts of their range in this region. Numbers in the Hunters Range, on the Region 3 boundary, are diminished (see Section 2.2.1). Caribou are apparently absent from former ranges between Mabel Lake and Sugar Lake. Caribou have been extirpated from the Grizzly Hills, where they were hunted early in this century. Caribou were known from the Whatshan Range and upper Kettle River in the early 1950's, but their presence today is uncertain.

Numbers, status and management

Caribou populations in Region 8 are discussed in Section 2.2.1

2.3.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Map 4a): Little information is available. Caribou have been seen in forests in the ESSF zone on the plateau south of Greenbush Lake, and around Peters Lake in Monashee Provincial Park. Anecdotal evidence suggest use of wintering areas east of the height of land (A. Frisby, pers. comm.). Other winter use areas probably exist, but have not been detected. Like caribou of adjacent regions, these animals are believed to use arbooreal lichens during winter.

Spring: Little information is available. There is one report of caribou feeding on slides south of Gates Creek during June (A. Frisby, pers. comm.).

Calving: According to a local trapper, calving has occurred in South Fosthall Creek (A. Frisby, pers. comm.).

Summer: Most summer observations have occurred in the alpine in Monashee Provincial Park and along the height of land north of the park. Some summer use of the Joss Mountain - Wap Creek area also occurs. Whatshan Peak in the south, and Mount Griffin in the north, have been reported as summer ranges, but may not be currently in use (A. Frisby, pers. comm.).

Rutting areas: No information is available.

Fall/early winter (Vol. 2, Map 4a): We have little information. South Fosthall Creek, the Joss Mountain area, and ranges near Upper Arrow Lake have been suggested as possible fall/early winter ranges.

Movement routes and special habitats (Vol. 2, Map 4a): Little information is available. A movement corridor at Wap Lake connects Joss Mountain with the Mount Griffin - Hunters Range area.

Factors affecting caribou habitat

Logging: The caribou range in Fish and Wildlife Region 8 is part of the Kamloops Forest Region, and the comments on logging in Section 2.2.2 are generally applicable.

The caribou range south of Greenbush Lake is rugged country that follows the crest of the Monashee Mountains. Logging in that area has been largely confined to lower slopes and has included high-grading of cedar, selective logging, and clearcutting. Rugged topography has limited logging on upper slopes, which support large Environmental Protection Areas. The Joss Mountain and Mount Griffin areas, north of Greenbush Lake, are less rugged and have been more extensively logged. There are large areas of old diameter limit logging and more recent clearcut logging in Engelmann spruce - subalpine fir stands and in mixed valley bottom types.

Blowdown has been a problem throughout this caribou range where partial cut methods have been used. Except where diameter limit prescriptions have been applied as a habitat protection measure for caribou, the current practice is to clearcut log, broadcast-burn or windrow and burn, and plant with

Douglas-fir, spruce, or sometimes lodgepole pine. Little stand-tending is currently practised (J. Robinson, pers. comm.)

Transportation corridors and access: Logging road access is extensive in the northern part of the region. There is road access up the Shuswap River north of Sugar Lake, and into some of the eastern tributaries of the Shuswap River. Monashee Provincial Park is accessible from the west by a hiking trail along Spectrum Creek. From the east, it is approached by a logging road along Fosthall Creek.

Fire history (Vol. 2, Map 4b): Scattered forest fires have occurred throughout the caribou range, but most were relatively small. Fires during the 1960's north of Greenbush Lake and in Tsuius Creek probably affected caribou habitat.

Insect attack (Vol. 2, Map 4b): Small areas of spruce beetle attack exist throughout the Monashees. Large areas have developed near Greenbush Lake since Map 4b was prepared (D. Jones, pers. comm.). Beetle attacks have also been identified in the Sugar Mountain area and along the Shuswap River near Gates Creek, both in areas where caribou use is doubtful.

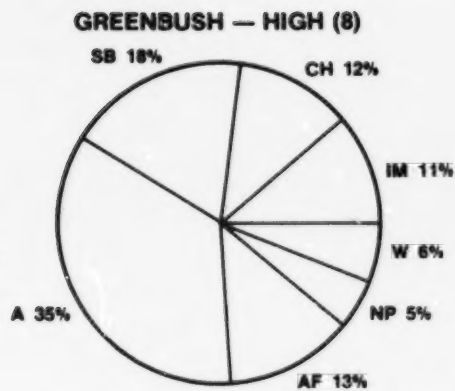
Other developments and human activities: Monashee Provincial Park, especially the Peters Lake area, is heavily used by hikers during summer, and the potential exists for disturbance of caribou (R. Howie, pers. comm.). Heliskiing developments east of Greenbush Lake are also of concern to wildlife managers.

Status of habitat in caribou ranges

Inventory data were available only for the Greenbush winter range (Fig. 5). The boundaries of that range were drawn to exclude the 1960's fire north of Greenbush Lake, but the relatively large percentage of immature timber in the area probably includes portions of that burn.

Landsat mapping indicates that the winter range located in Monashee Provincial Park is composed entirely of mature timber and alpine areas.

**FIGURE 5. Status of habitat in caribou ranges:
Region 8.**



LEGEND			
IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other
Categories with less than 1% are grouped into OTH			

Forest management planning

Caribou ranges in Fish and Wildlife Region 8 are part of the Okanagan TSA, discussed in Section 2.2.2. The timber industry faces a short-term supply deficit as well as long-term falldown. There is no local shortage of timber in Region 8 caribou ranges, and logging costs are high in the Monashees because of rugged topography. However, the area may experience some extra logging pressure because of supply deficits elsewhere in the TSA.

Habitat protection

Habitat protection measures for caribou are focussed on the area with the most extensive undisturbed habitat, which lies between Greenbush Lake and Monashee Provincial Park. The general policy is diameter limit logging between 4500 and 5500 ft (1372 and 1676 m), and no logging at higher elevations. In practice, there have been few logging referrals in this area, because much of the caribou range is presently inaccessible. In the late 1970's, spruce was harvested to an 11 in. (27.9 cm) limit in two spruce - subalpine fir stands in the Greenbush Lake area. Much of the residual stand was lost to blowdown in a major windstorm. Habitat Protection staff have requested a total reserve on the remaining Greenbush caribou range. That reserve is currently threatened by outbreaks of spruce bark beetle, and salvage logging to a 9-in. (22.4-cm) limit for spruce and a 17-in. (43.2-cm) limit for subalpine fir has been approved (D. Jones, pers. comm.).

2.3.3 Information needs

The information base on caribou in this region is extremely limited. Few aerial surveys (other than CLI flights) and no special studies have been conducted. There is a need to identify seasonal ranges, special habitats, and movement routes. A request has been made by Fish and Wildlife staff for biophysical mapping in the Greenbush Lake area (D. Jones, pers. comm.). General ecology of the animals may be inferred from studies carried out in adjacent regions.

2.3.4 Information base

Aerial surveys

CLI flights: 1&2/68

Incidental sightings - about 25. Major source A. Frisby.

2.4 Nelson Forest Region - Fish and Wildlife Region 4

2.4.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Maps 1a, 2a, 3a, 4a, 5a): Widely distributed throughout the Kootenay Region west of the Rocky Mountain Trench. Apparently present throughout the northern part of the region (GMU's 4-37 to 4-40 and the northern half of 4-36), although their status east of Kinbasket Lake is uncertain. Present in the Purcell Mountains east of Kootenay Lake, the Selkirk Mountains north of Kootenay Lake, and the Monashee Mountains as far south as Monashee Provincial Park and possibly Whatshan Peak. Status uncertain in the Kootenay Glacier Park area. At least sporadically present in the the Valhalla Range and the Bonington Range west of the Salmo River, and regularly present in the southern Selkirks between the West Arm of Kootenay Lake and the U.S. border. Also present in adjacent Idaho, Washington, and occasionally Montana.

Detailed information on present and historical distribution is in Russell et al. (1982).

Historic changes in distribution: Caribou were formerly present in the southern Monashee Mountains and west to the Okanagan Highlands (Russell et al. 1982). They were also more widely distributed in the United States, occurring as far south as Wyoming in the 1870's. They were thought to have disappeared from the Yahk Range in the southern Purcells until five animals were photographed near the headwaters of the Yahk River in February 1984. They are not known to have occurred historically in the southern Canadian Rockies, but caribou remains have been found in the Flathead Watershed in Montana (Russell et al. 1982), and caribou tracks were observed in that area in the winter of 1983-84 (G. Woods, pers. comm.).

Numbers, status and management

Russell et al. (1982) have provided a thorough review of population and management history and status of caribou in the Kootenay Region through 1975, and their account serves as the basis for our following area-by-area analyses. As shown in Appendix 1, Region 4 (Vol. 2) and Appendix 1 (this volume), caribou observations in the Kootenays are greatly scattered in both

time and space, and were mostly obtained opportunistically. Actual census activity has not been a realistic possibility because of the relative paucity of information on pertinent aspects of the animals' biology, including population boundaries, extent and nature of seasonal movements, and factors affecting use of various habitats. In short, it is difficult to count animals unless one has at least a general idea of where most of them are at some time of the year, and whether they occur at such times in habitats in which they can be seen.

Interpretations on populations from available observations are subject to opposing biases. If one assumes that the animals are relatively sedentary, as Russell et al. (1982) apparently have, then observations from different locations even though from different time periods, are additive. Obviously, if counts from different locations actually involve the same animals, the net result will be an over-estimate of population size. On the other hand, the absence of observations from many areas may simply reflect an absence of observers or failure of observers to report. For example, Herbison (1973) pointed out that many of the past observations from the Duncan-Lardeau area were by men who lived in the bush for weeks or months at a time, while mining or trapping, and many of those areas have not been occupied regularly for several decades. Although roads and other human developments are relatively profuse in the Kootenay region, there are nevertheless fairly large expanses of potential caribou habitat that are seldom visited by man and, in a population evaluation system which relies upon incidental observations for its baseline data, there is a chance that some animals are not being accounted for, and population estimates are thereby biased downwards.

There is some justification for considering Kootenay caribou to be more sedentary than caribou elsewhere. Recognizable individuals have been seen and photographed repeatedly among the International Boundary animals and apparently also among those in the Poplar Creek area. Those observations suggest a degree of isolation between those groups, and others, and indicate the possibility that other groups may exist similarly. Lack of knowledge about the degree of isolation between the caribou in the various areas to be discussed probably constitutes the greatest impediment to our understanding of populations in the total area. However, four of the southern Selkirk caribou have recently been radio-collared (Scott 1983) and their movements and those

of the instrumented animals in the Columbia River area north of Revelstoke should be pertinent. K. Simpson (pers. comm.) has shown some fairly large movements in the latter area, sufficient to illustrate the potential for counting the same animals at different locations; at the same time, regular patrols to look for the collared animals in Simpson's study area have enabled him to contact and count other animals which might not otherwise have been accounted for. Hence, the potential for both types of bias mentioned above are illustrated by results in that area.

For the purposes of discussion, Russell et al. (1982) subdivided known Kootenay caribou range into 11 areas, with reference to the four major north-south running mountain ranges in the region. Following are our comments on those areas:

1. Monashee Mountains (South): GMU's 4-09 and 4-14.

Russell et al. (1982) used reports from the B.C. Game Commission to document the fact of historic occurrence of caribou in this area, and that they had mostly disappeared by the mid-1950's. We have no records of observations over the past three decades.

2. Monashee Mountains (Central): GMU 4-32.

Based on information available to them, Russell et al. (1982) projected a 1975 population of about 24 animals for this area, including about 10 in Monashee Park and another 10 some 25 km north, in the Coursier Lake area. We have not seen the original data and have come up with no new records, thus we have little basis for comment. However, it appears evident that there is strong potential for duplication in the sightings indicated above. Possibly many of the animals seen in the past in the central or southern portions of 4-32 and in adjoining units 8-23 and 8-24 may have been wanderers from elsewhere, particularly from the east and possibly also from the north. The few sightings reported by hikers in the area in recent years may involve animals that are more or less resident there.

There has been no legal hunting in the central Monashees since 1972.

3. Monashee Mountains (North): GMU 4-39.

Russell et al. (1982) speak of two "populations" in the southern portion of this unit, separated along the same height-of-land by a distance of 25-30 km. It is more likely that these should be considered two centres of occurrence, and that the population extends north over most of the management unit, to the west (as they suggest) into the Thompson drainage of Region 3 and east across the Columbia into GMU. 4-38 and possibly beyond.

A preliminary report (Simpson and Hebert 1982) produced a composite population estimate for areas adjacent to the Columbia in both GMU's 4-39 and 4-38. The information associated with that estimate is worthy of some discussion. Table 5 in Simpson and Hebert (1982) lists 21 locations at which caribou were seen on one or more occasions during the period February 1981 to March 1982. Most (13) were west of the Columbia in GMU 4-39, while the remainder were in mountains east of the river in GMU 4-38.

Their population estimate is based upon calculation of an arithmetic mean for the number of animals seen at each location over the study period. For example, in four visits to Ratchford Creek, counts ranged from zero to ten, with a mean of five. Adding results for all 21 locations, the maximum number seen (sum of the highest counts for each location) was 184, while the total of the means (the population estimate) is 118. Approximately 60% of the animals indicated above (mean = 72, maximum = 105) were in GMU 4-39. Russell et al. (1982) had estimated a total of 75-80 animals for the 4-38 and 4-39 area; thus the results discussed above suggest a higher population there than expected. More recent results, based on projections from observations of marked animals during census work, indicate an even higher mean estimate of 255 animals (Simpson et al. 1984b).

In the composite sample for 1981, Simpson and Hebert (1982) found 18% calves and 10% yearlings. Considering that half of the adults in the sample were said to be bulls, these data suggest very good survival of young animals and Simpson is probably correct that they indicate the herd(s) may be increasing at least slightly. However, little is known of adult mortality in the area.

The northern Monashees area has long been managed together with the northern Selkirks and northern Rockies, all of which have remained open to limited hunting. As noted in Appendix 4 (Vol. 2), prior to the establishment of the Game Management Areas in 1956, the "Revelstoke Electoral District," particularly that portion north of the Canadian Pacific Railway (CPR) mainline, was apparently considered exceptional in animals available, and liberal seasons pertained from the early 1930's until the early 1970's. In the late 1940's and early 1950's that area was actually managed with the same seasons applied to areas in the northern half of the province.

We have no harvest figures for the early years. Russell et al. (1982) compiled Hunter Sample information for the years 1964-1971, showing a total estimated harvest for that period of only 24 for the north Monashees, 13 of which were in 1968 when an early snowfall forced animals into newly accessible lowlands in the Jordan River drainage. As described by Russell et al. (1982), caribou hunting pressure throughout the Kootenay Region peaked in about 1964, during a period of long either-sex seasons, but had declined considerably by the early 1970's. By then a more conservative approach to management resulted in closures over most of the region and restrictions to short, bulls-only regulations where hunting was retained. Estimated total kill for MA 9 (present GMU's 4-36 through 4-40) for 1972-1975 was 0,0,4 and 0, respectively, and for GMU 4-39 alone in 1976-1981 the figures are 2,0,0,4,0, and 0, respectively (Hunter Sample). Compulsory inspection records show a total reported kill of three in the years 1977-1982, including two (1 and 5 years old) in 1979 and one (9 years old) in 1980. Thus, it appears that the legal harvest has been negligible for over a decade, although K. Simpson (pers. comm.) notes that there have been "several" illegal and/or accidental kills in that area in recent years.

4. Selkirk Mountains (south): GMU's 4-07 and 4-08

The southern Selkirk or International Boundary herd is, as described by Bergerud (1978), the "most famous" group of caribou in the Kootenay Region. It has been much studied although generally without the benefit of marked animals (Freddy 1974a; Freddy and Erickson 1975; Layser 1974;

Johnson and Miller 1979). Regarding population status, the general consensus from the above studies is that the herd numbers about 25-35 animals, existing mostly as scattered small bands, and that recruitment potential is high, averaging about 20%. A reliable minimum population figure of 26 was obtained in an extensive helicopter survey of the area by Scott (1983), and more recent data from his studies put that number at about 31 in June 1984 (G. Woods, pers. comm.).

Our data (Appendix 1, Region 4 [Vol. 2] and Appendix 1 [this volume]) do not allow any significant population analyses, since most involve observations in the localized vicinity of the summit on the Salmo-Creston Highway, and the extent of duplication cannot be ascertained. A peculiar aspect of the data is the frequency of large group sizes in one year. Fewer than 25% of observations over the 9-year period between 1974 and 1982 involve group sizes larger than 10 and over half of those were in 1976. The first was a trapper's report of "20-25" in the Hidden Creek area in February. Most were between February and May of that year, but there were some in November and December. The last of those involved 26 animals and, if accurate, indicates that almost all of the southern Selkirk herd may have been in one location (the Salmo-Creston summit) at that time.

Bergerud (1978) observed that "studies of this herd illustrate that the cause of mortality can be determined, even for elusive arboreal lichen caribou." The basis for his statement is reports of caribou killed by collision with vehicles along the Salmo-Creston Highway. Clearly that source of mortality is rather easy to document. However, other sources, except for some past poaching (Layser 1974), are poorly known. The vulnerability of this herd has long been recognized and it has been closed to hunting since 1957.

The International Boundary herd appears to be isolated from other groups of caribou. Observations to the west, in the Bonnington Range (No's 1,2,13 in Vol. 2, Appendix 1, Region 4 [Caribou sightings]) almost certainly involve wanderers from the Nelson Range and not a separate group. The nearest caribou range that is at least occasionally occupied is in the southern Purcells. Russell et al. (1982) noted that in the 1800's, caribou migrated "in large numbers" across the Creston Valley,

but that the phenomenon "ceased prior to European settlement." Based on the observation of a historic link between the southern Selkirks and the southern Purcells, there is a possibility that some interchange may still occur. We are aware of no pertinent sightings in British Columbia. However, the implied crossing(s) of the Kootenay Valley could occur south of the International Border. Recently initiated radio-tracking studies, under the auspices of the International Mountain Caribou Technical Committee, should help to better delineate population boundaries.

5. Selkirk Mountains (central): GMU's 4-15, 4-16, 4-17, 4-18, 4-28, 4-29, 4-30, 4-31 and 4-33.

Russell et al. (1982) concluded that GMU's 4-15, 4-16 and 4-18 support few caribou at present, and those that do appear in these units may be from areas to the north. We have no information to the contrary. For the remaining six units the above authors suggest a total of about 85 animals, occurring in roughly four groups. They acknowledge that some interchange between those main groups may occur, and that the remote and relatively pristine mountains in the Upper Duncan/Incomappleux area may support as yet "unknown bands of caribou."

One of the four groups mentioned above, dubbed the Kuskanax/Bremner/Hamling group by Russell et al. (1982) and estimated by them to contain 20-25 animals in 1975, has been the focus of some intensive local studies. J. Harling and J. Snyder (unpubl. data), have compiled historical records based on interviews and have made numerous observations in the field. However, their own apparently limited mobility in the area and the absence of marked animals make interpretation of population status from their data very difficult. Nevertheless, Bergerud (1978) considered their total counts from 1974 through 1977 to represent the total "population". His calculations showed mortalities of 35% between 1974 and 1975, an additional 50% between 1975 and 1976, followed by 9% over the following year. The figures indicated a total population in 1977 of 10 animals, with no calves or mature bulls. He noted that the situation "... points to true isolation of this relic (sic) group ..." and recommended immediate action in terms of restocking and better law enforcement (Bergerud 1978:19).

Unfortunately we have no further observations from that area after 1978, but it seems unlikely that the "Poplar Creek herd" was/is actually isolated. Indeed, observations through the mid-1970's are relatively continuous over the entire area from Highway 6 north to the Duncan River, and the term "population", used here to describe a group of animals with at least the potential for continuous interchange, is probably applicable to the caribou over all of that area and beyond, i.e. north to at least Glacier National Park and east into the Purcells.

As noted earlier the estimate by Russell et al. (1982) of about 85 animals for the area west of the Duncan involves separate estimates for four sub-groups. The numbers for those four sub-groups range from 17 (Halfway-St. Leon) to 27 (Lake Creek). However, there appears to be no evidence that such numbers have ever been known to be occupying their respective areas at the same time. That is, the actual total may be considerably less than 85 if there are, in fact, no "unknown bands" in the presently inaccessible areas to the north.

B. Herbison (unpubl. data) compiled a massive list of observations and recollections relating to caribou occurrence in the area from the 1930's to the late 1970's. She obtained many reports of "large numbers" in the early years, but when actual figures were used, most observers were speaking of groups up to about 30. The largest number reported for any one area in the central Selkirks was 60, at Wilson Lake (GMU 4-17) in early winter 1967 (No. 93 in Vol. 2, Appendix 1, Region 4 [Caribou sightings]). The most recent observations for the area are from Kootenay Forest Products employees in the upper Duncan area in 1978, as recorded by Herbison (unpubl. data). They include an observation of a lone calf near the mouth of Hall Creek in September, nine animals at the mouth of Hume Creek in October, and one bull there two weeks later. Those observations show only that Bergerud's (1978) fears of a non-reproductive population, based on Harling and Snyder's 1977 data at Poplar Creek, did not apply to all of the central Selkirks area.

There is evidence of fairly heavy hunting in the central Selkirks in the late 1960's and early 1970's. The estimated kill from 1964 through 1971, as recorded by Russell et al. (1982) from Hunter Sample records, was 110 animals, of which only 54% were males. By far the biggest year among

those records was 1967, when the projected harvest was 12 in the Halfway area and 15 from the Kuskanax drainage, a total of 27 among which only one-third were males. Recall that 1967 was the year that 60 animals were reportedly observed in the Wilson Lake area.

Harling and Snyder (unpubl. data) had reports that 25-30 animals were killed in 1970 or 1971, in the vicinity of the North Fork of the Kuskanax. This supposedly occurred following the opening of a new road after a fire. Russell et al. (1982) mention a "relatively high kill" in the Kuskanax watershed in 1971", but the Hunter Sample data for that year indicates a total central Selkirks kill of only 12, including three from Kuskanax and nine from Halfway. Note that the Halfway Road opened in 1971, thus the increased kill there is due to new access. The Hunter Sample data show no kills for the above areas in 1970. It seems apparent that many kills went unreported, thus the actual harvest history, like that for populations, will never be known for sure. As with the rest of the Kootenays south of the Big Bend area, legal hunting in the central Selkirks ceased in 1972.

6. Selkirk Mountains (north): GMU's 4-37 and 4-38.

Russell et al. (1982) estimated that there were about 85 animals in the northern Selkirks in 1975. The radio-tracking studies by Simpson and Hebert (1982) are being conducted partly in that area, as discussed in the section on the north Monashees. Their 1981 population estimates for locations in the study area east of the Columbia totaled about 40, and that apparently did not include any of GMU 4-37. K. Simpson (pers. comm.) notes that those animals frequently interchange between 4-37, 4-38, and adjacent Region 3, and that population by GMU varies.

The management history for this area has already been described in the section on the north Monashees. A short hunting season has been maintained to the present, and the kill has remained light. In the Hunter Sample compilation by Russell et al. (1982), only nine animals were estimated to have been taken in the 8-year period 1964-1971. Only four more were estimated in all of the Big Bend area (present GMU's 4-36 through 4-40) between 1972 and 1975. Since 1975, when the present GMU's were established, there have been no kills reported from 4-37; in 4-38 a

total of three animals was estimated to have been taken in 1976, four in 1977, and one in 1982. If reports are accurate, then hunting appears to be a negligible factor in the demography of caribou in the northern Selkirks.

7. Purcell Mountains (south): GMU's 4-03, 4-04, 4-05, 4-06 and south portion of 4-20.

Russell et al. estimated a 1975 population of about 30 animals north of the southern trans-provincial highway, and showed estimated harvests averaging over 11 animals per year from 1964 to 1971. They note that "logging and access" have reduced the number of caribou in at least parts of the area. There are records of some fairly large groups in recent years, including 17 in 1979 in 4-05, 18 in 1980 in 4-06, and 19 in 1982 back in 4-05. No caribou are known to occur in 4-03, and there has been only one documented sighting in 4-04, five animals photographed near the head of the Yahk River in February 1984. We have no population figures for years prior to the hunting closure in 1972, but numbers must have been substantially higher than at present, since the male component of the harvest held up rather well. All of the nine animals estimated to have been taken in 1971, the last year of legal hunting, were males. There is no basis for speculating on the present population trend in the southern Purcells. There is a possibility that some or all of the animals seen there in recent years may be wanderers from elsewhere, including the southern Selkirks. However, R. Demarchi (pers. comm.) believes they represent a viable resident population.

8. Purcell Mountains (north): GMU's 4-19, north portion of 4-20, 4-26, 4-27, 4-34.

We have almost no information from this area except scattered observations from Glacier Park staff, and none of these suggest high numbers over the past several decades. The area was among those closed to hunting in 1972, although kill records compiled by Russell et al. (1982) do not reveal any kills there in the 8 years prior to that time. The 1975 population estimate for the north Purcells is 20 (Russell et al. 1982) but they point out that much of the area is remote and little known.

Interchange with animals from adjacent areas, especially the central Selkirks, is likely.

9. Rocky Mountains (south): GMU's 4-01 and 4-02.

Russell et al. (1982) note that there are presently no caribou in these units and that there is no substantiated evidence that they occurred there historically.

10. Rocky Mountains (central): GMU's 4-21 through 4-25.

As noted by Russell et al. (1982), there are probably no resident caribou in this area. Occasional movements into the area from the north are possible, although we have no records of such occurrence. There has been no caribou hunting season in the central Rockies since 1972, and we are aware of no kill records there.

11. Rocky Mountains (north): GMU's 4-35, 4-36 and 4-40.

Little is known about the caribou in this remote part of the region. Russell et al. (1982) reported an observation of eight animals near Blackwater Lake in 1973 and estimated a total of just 10 for the entire area. They noted that at least one caribou is known to have drowned in the filling reservoir behind Mica Dam and speculate that traditional migration routes and crossings may have been obstructed by the flooding. We have only one additional record, three animals seen at the mouth of Kinbasket Creek (McNaughton Lake, GMU 4-40) in February 1982. Animals in that area could conceivably have affinities to herds to the west (Big Bend area/North Thompson), but are more likely either from the North (Region 7/Jasper) or are resident in the GMU 4-36 and 4-40 area. We are aware of no records from GMU 4-35, and Demarchi (pers. comm.) considers it unlikely that any caribou are resident there.

As with the other GMU's in the former "Big Bend Management Area" (MA 9, 1967-1974), a short open season for bulls only has been maintained for caribou in the northern Rockies but hunting pressure has been negligible (only nine hunter days reported in total for the years 1976-1981, Hunter Sample), and no kills have been documented.

Concluding comments: Overall, the picture of caribou occurrence in the Kootenay region is most confusing. The animals are widely distributed, and in a variety of at least somewhat different habitats. As the farthest south regularly occurring caribou, these animals in the southeast corner of British Columbia have considerable ecological significance. Yet, in their apparent sparseness on the ground and in the hunter's bag, and in the difficulty of obtaining meaningful data on them, especially in comparison with the several other ungulate species in the area, they have remained a low priority in terms of both local management and research activities (R. Demarchi, pers. comm.).

The total 1975 regional population estimate by Russell et al. (1982) is 415 animals. That figure is the sum of the separate estimates (Table 4) for the 11 sub-areas discussed above and, as such, is subject to the various conflicting biases discussed for each. Whatever the actual current regional population, it is apparent that it is considerably smaller than that pertaining historically.

Our understanding of what has happened to the caribou over the years is less than perfect. R. Demarchi (pers. comm.) suggested that the species is essentially a "post-pleistocene relict" which has not been able to adapt to the environmental changes promoted by changing climates. Yet, there is little doubt that man has frequently been a negative factor. Several references have pointed to "hunting for the pot" during the early part of the century, when prospectors and other bush dwellers were much more common than today. One particularly revealing statement in this regard appeared in a letter from long-time Kootenay resident George Oliver (letter to R. Demarchi, August 1975), " ... now I don't want to shoot any more caribou myself as I still owe them a debt in the hungry 30's (they) helped me to feed 7 hungry kids of mine."

Oliver and others have also noted that some important winter feeding areas have been removed by logging, but direct effect on populations as a result of such removals, or by effects of ancillary developments such as road access, or by other developments such as hydro-flooding have often been suggested but never well documented. As is still true today, too little has been known of Kootenay populations to enable detection of changes.

TABLE 4. The location and estimated numbers of caribou in Region 4 in 1974-1975, from Russell et al. (1982)

Mountain System	Herd	Management Unit	Lower limit	Median estimate	Upper limit	
Monashee	Central	Monashee Pk	4-32	5	10	
		Pingston	4-32	5	10	
		Whatshan	4-32,8-13			15
			4-14	2	4	6
		TOTAL		12	24	36
	South	TOTAL		0	0	0
	North	Jordan	4-39	25	30	35
		Ratchford	4-39	15	20	25
		Ratchford/Negel	4-39	20	25	30
		TOTAL		60	75	90
	MONASHEE TOTAL			72	99	126
	Selkirk	South	Nelson/Bonnington	4-07,4-08	25	30
TOTAL				25	30	34
Central		Valhalla	4-15,4-16	3	5	8
		Kokanee Pk	4-17,4-18	10	12	14
		Kuskanax/Bremner/Hamling	4-17,4-30	20	22	25
		Halfway/St. Leon	4-31	15	17	20
		Lake Creek	4-29	25	27	30
		Duncan/Incomapleux	4-28,4-33	10	20	30
		TOTAL		83	103	127

TABLE 4. Continued

Mountain system	Herd	Management Unit	Lower limit	Median estimate	Upper limit	
Selkirk cont'd.	North	Downie/Revelstoke	4-38	30	35	40
		Goldstream	4-38	10	15	20
		Bigmouth/Louis Lee	4-38	10	15	20
		Gold/Austerity	4-37	15	20	25
		TOTAL		65	85	105
	SELKIRK TOTAL			173	218	266
Purcell	South	Sanca-Skelly	4-06,4-20	5	7	9
		Moyie/Lamb	4-05,4-20	15	17	20
		France	4-06,4-20	6	7	8
		TOTAL		26	31	38
	Central	Alton/Skookumchuck	4-26	20	25	27
		Fry/Hamill	4-27	10	12	15
		TOTAL		30	37	42
	North	Howse Creek/Prairie Hills	4-27,4-34	10	20	30
		TOTAL		10	20	30
	PURCELL TOTAL			66	88	110
Rockies	South	TOTAL		0	0	0
	Central	TOTAL		0	0	0
	North	Wood/Bush	4-35,4-36	5	10	15
	TOTAL		5	10	15	
	ROCKIES TOTAL			5	10	15
REGION IV TOTAL				316	415	502

2.4.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Maps 1a, 2a, 3a, 4a, 5a): Specific winter ranges are poorly known outside a few research areas: Glacier National Park, the Columbia drainage north of Revelstoke, the Kuskanax-Bremner Creek area, and the Salmo-Creston summit area. Parkland and closed-canopy Engelmann spruce - subalpine fir forests are consistently used by caribou during this period, and arboreal lichens are the main forage item (Munro 1945; Herbison 1973; Freddy 1974a; Hamer 1974; Russell et al. 1982; J. Harling and J. Snyder, unpubl. data; K. Simpson, pers. comm.). Some cedar - hemlock forests are used (Herbison 1973, Freddy 1974a). Freddy reported that caribou tended to use the upper cedar - hemlock/lower spruce - fir zone (1400-1525 m) through February, and the upper spruce - fir zone (1525 m +) beginning in March. However, the elevation shift was not marked. In 1980-81, caribou in the Revelstoke area moved to subalpine forest habitat in late December, but in 1981-82, they did not move upslope until the first major thaw of the season occurred in early February.

Spring: Use of low-elevation habitat in spring has been documented in the northern part of the region. Hamer (1974) reported use of a valley bottom (1160 m) Engelmann spruce - subalpine fir forest interspersed with wet meadows from April through mid-June 1972; the animals were believed to feed initially on arboreal lichens, and then on green vegetation as it became available. Munro (1945) reported use of similar habitats in the eastern part of Glacier National Park. In the Revelstoke area, caribou fed on horsetails, grasses, sedges, herbs and shrubs in low-elevation clearcuts and slides during April and May (K. Simpson, unpublished data). In the Kuskanax-Bremner Creek area, caribou were observed from 1220 to 1980 m during May 1974; their pellets indicated that they were feeding on green vegetation (J. Harling and J. Snyder, unpubl. data).

In the Salmo-Creston area, Freddy and Erickson (1975) concluded that caribou remained in late winter habitat during this period, and did not move to lower elevations. However, preliminary findings of Scott (1983) suggest that a seasonal shift in elevation may occur: caribou that were radio-located during May were at lower elevations than unmarked animals observed during

winter. The collared animals were using clearcuts where green-up had begun, and adjacent timber stands.

Calving season: Calving areas are poorly documented. There is a general belief that calving occurs in snow-free areas at high elevations (Freddy 1974a; Russell et al. 1982). On the basis of limited observations in 1976, D.R. Miller suggested that Selkirk caribou probably calved in or adjacent to the headwaters of Carolina Creek (International Mountain Caribou Technical Committee files). Radiotelemetry data of K. Simpson (unpubl.) indicated that cows probably moved to snow-covered areas before or shortly after calving. A timbered ridge near snowline in Mount Revelstoke National Park was identified as a possible calving site. Bulls appeared to remain at low elevations during the calving season.

Summer: Most observers have reported that caribou occupy primarily alpine habitat during summer (Munro 1945; Hamer 1974; Freddy and Erickson 1975; Russell et al. 1982; Van Tighem 1982; J. Harling and J. Snyder, unpubl. data). Hamer (1974) observed caribou in small alpine basins, but not in areas where gently sloping alpine terrain was extensive. Harling and Snyder (unpubl. data) characterized summer habitat as moderately sloped, alpine and subalpine areas where moist herb/sedge meadows were interspersed with snowfields and forest patches or alder slides. They noted heavy feeding in an alpine meadow on Erythronium grandiflorum, Luzula parviflora, Juncus spp., and Vaccinium membranaceum.

Caribou also use forested areas during summer. McCrory and Holland (1977) noted that caribou in Glacier National Park seemed to frequent valley bottoms more than the alpine at that time. K. Simpson (unpubl. data) observed that, in 1981, most caribou in his Columbia River study area apparently moved to valley bottoms in spring, and some moved to alpine areas by midsummer, but others remained low. On 14 and 15 August, he searched the alpine in his study area and found no caribou or tracks; the animals were evidently in the timber.

Rutting season: Although most observers indicate that caribou have departed from the alpine by the rutting season (K. Simpson, unpubl. data; J. Harling and J. Snyder, unpubl. data), there is little information on actual

rutting areas. J. Harling and J. Snyder (unpubl. data) and D.R. Miller (International Mountain Caribou Technical Committee files) suggested that there is considerable movement during the rutting season. K. Simpson (unpubl. data) also observed increased movement during that period, most commonly in Engelmann spruce - subalpine fir forests. The only confirmed report of a rutting band is that of Miller, who observed rutting behavior in a mature stand of subalpine fir at the base of a steep slope in upper Curtis Creek.

Fall/early winter (Vol. 2, Maps 1a, 2a, 3a, 4a, 5a): In most parts of the Kootenay region, caribou are reported to use low elevation forests in fall and early winter. In the northern Monashees, caribou used forests in the ICH zone, where they fed on lichens from litterfall, blowdown, and felled trees, as well as evergreen shrubs such as Pachistima myrsinites and Pyrola spp. (Simpson and Hebert 1982 and unpubl. data). In Glacier National Park, Hamer (1974) observed the use of low elevation forests in this season; Van Tighem et al. (1982) noted only that caribou sightings ranged from 790-1615 m, which corresponds to the forested zones. Caribou in the central Selkirks have frequently been seen between 600 and 1375 m in fall and early winter, often feeding on lichens in mature cedar - hemlock stands (Herbison 1973; J. Harling and J. Snyder, unpubl. data). Russell et al. (1982) commented that in some years the period of soft snow, during which caribou rely on ground vegetation, may last until March.

In the southern Selkirks, Freddy (1979) did not detect a distinct seasonal shift in the elevations at which caribou were found. D.R. Miller (International Mountain Caribou Technical Committee files) observed that after fall snows began, some caribou remained at higher elevations and used arboreal lichens on windthrows, while others moved below 1220 m where snow depths were less. Preliminary indications from the work of M. Scott in the southern Selkirks are that a move to low-elevation forests does occur in early winter (G. Woods, pers. comm.).

Movement routes and special habitats: Known and suspected movement routes and licks are shown on Maps 1a, 2a, 3a, 4a, and 5a. Kootenay Pass, at the summit of the Salmo-Creston highway, is the only known travel route between caribou ranges in British Columbia and the United States (Freddy 1979). A

traditional crossing of the Columbia River at Wigwam is no longer used (A. Frisby, pers. comm.).

Factors affecting caribou habitat

Logging: As in other parts of the province, managers in the Nelson Forest Region have experimented with various logging systems, in search of the best means for achieving regeneration (A. Waldie, P. Fowler, pers. comm.).

Diameter limit cutting was the dominant logging system until the early 1950's. Typical DBH limits were 12-in (30.5-cm) for hemlock, cedar and lodgepole pine, and 18-in (45.7-cm) for other species. That system was more successful in dry timber types than in caribou habitat. It was largely replaced in the early 1950's by a selection cutting system, in which trees were marked for cutting by a forester. The success of selection cutting in achieving natural regeneration was variable.

In the late 1950's, loggers began clearcutting to intermediate utilization standards and leaving marked seed blocks. Typically, the seed blocks were effective in achieving regeneration only over a distance of about 200 m.

Selection cutting and clearcutting with seed blocks remained the dominant logging systems until clearcut logging to close utilization standards came into effect in 1966. Clearcutting has resulted in severe brush problems in some cases, especially with rhododendron on good spruce sites. Ideally, clearcuts are limited to 40 ha to minimize blowdown, to prevent excessive drying in the centre of the opening, and for esthetic reasons. In practice, however, many clearcuts are much larger.

Since the mid-1970's, various partial cuts have been tried in spruce - subalpine fir types, either for silvicultural reasons or in consideration of other resources. Some have been diameter limit cuts, and others have been limited to removal of beetle-killed trees. Some of those partial cuts now support little mature timber, as the residual stand was salvage-logged after it blew down or was attacked by spruce beetles; others have remained stable. Partial cutting for the specific purpose of protecting caribou habitat has taken place only in the southern Selkirk Mountains (K. Milner, pers. comm.)

Reliance on natural regeneration in the past has resulted in considerable areas of forestland that are not satisfactorily restocked, especially in the Kootenay Lake TSA. Silvicultural policy today calls for immediate planting,

but stock is limited by nursery facilities. Scarification is commonly used in all timber types. Burning is used less frequently than in the past. Some juvenile spacing is done, especially in lodgepole pine and in advanced regeneration subalpine fir. So far, there has been little commercial thinning (A. Waldie, P. Fowler, pers. comm.).

Transportation corridors and access: Access to caribou ranges is extensive in the southern and western parts of the region, due primarily to logging road development. In one instance, the effects of access on caribou were judged serious enough that the Carolina Creek road, which leads to a heavily used range, was closed under the Forest Act when logging was completed.

In the southern Selkirks, caribou habitat is bisected by Highway 3. This major all-weather road crosses an important movement route, leading to caribou mortality from vehicle collisions and from illegal hunting (Freddy 1974a; Johnson and Todd 1977). Bergerud (1978) considered the highway the primary mortality factor for the Selkirk caribou. The discharge of guns for avalanche control in the vicinity of the highway is a disturbance that causes caribou to flee the area (K. Milner, pers. comm.). A plan to reduce avalanche hazards by relocating the highway to the south side of Summit Creek is under consideration by the Ministry of Highways, but is not likely to be implemented soon. The proposed relocation concerns wildlife managers because it would encroach further on heavily used caribou habitat (A. Soobotin, pers. comm.)

In the central Selkirks, road development apparently contributed to high hunting mortality in some years. Caribou are sometimes seen along Highways 23 and especially 31, but we are not aware of vehicle collisions with caribou on those roads.

Large areas of inaccessible caribou habitat are found in the central and northern Purcells, GMU's 4-28 and 4-33 of the central Selkirks, the northern Selkirks, and the northern Monashees. This area is divided by a major transportation corridor, the Illecillewaet Valley, which is the route of the Trans-Canada Highway and the Canadian Pacific Railway. Historic occurrences of caribou along this route (and at least one caribou death from a train collision) have been documented by Van Tighem (1982), but there have been very few recent sightings in the valley. In the northern Purcells and in GMU's 4-28 and 4-33, roads in the Incomappleux, Duncan, Glacier, and St. Mary

drainages have penetrated some known or suspected caribou ranges. However, large areas of caribou habitat, especially at high elevations, are still inaccessible to motor vehicles.

Fire history (Vol. 2, Maps 1b, 2b, 3b, 4b, 5b): Numerous fires have occurred in the Kootenay region, especially during the 1940's and the 1970's. Because many caribou ranges are poorly known, the impact of fires is difficult to assess.

Few fires have occurred in the central Monashees, and impact on caribou seems unlikely. In the northern Monashees, there have been a number of scattered fires, mostly small. Frisby Creek and the north end of Frisby Ridge, which are immediately adjacent to a well-documented winter range, are in early seral stages as a result of several burns.

Fires in the south Selkirks have been numerous. Since 1940, fires have occurred in the Char, Waldie, Carolina, Bayonne, Blazed, Next, and Elmo Creek drainages. Parts of the Stag Leap and Lost Creek basins, and an area south of Ripple Mountain, are also in an early seral stage due to burns in 1920 (Johnson 1976). It is unclear whether large fires in the 1940's in Midge Creek and Corn Creek had any effect on caribou; these areas are peripheral to present-day ranges.

Many small and medium-sized fires have occurred throughout the central Selkirks, especially in the 1940's and 1970's. Burns in the Wilson Lake area and the Kuskanax drainage are clearly within known caribou ranges, and it is likely that many other fires have also affected caribou habitat.

In the north Selkirks many scattered fires, mostly small, have occurred since 1940. A concentration of several burns in the lower Tangier River drainage and adjacent areas has probably had an impact on caribou. Along the Canadian Pacific Railway corridor, numerous and extensive fires occurred during the late 19th century; many burns extended from the river to timberline on adjacent mountains (Van Tighem 1982). Today, those forests are still too young to support abundant lichen forage.

The south Purcells have experienced several large fires, mostly in the 1940's. A very large burn in the Moyie River drainage is adjacent to habitat that is actively used today. Fires in Duck, Arrow, and Kid Creeks, the Little Moyie River south of Highway 3, and in the St. Mary watershed may also have

had an impact on caribou. A number of scattered fires have occurred in the north Purcells. Of these, a large fire in the lower Howser Creek drainage and several burns in the upper Duncan River valley seem most likely to have affected caribou.

The impact of fire in the north Rockies is impossible to assess because caribou ranges are unknown. Large fires occurred in the 1970's in the Sullivan River and Blackwater Creek drainages; caribou have been seen in or near these areas.

Insect attack (Vol. 2, Maps 1c 2b, 3c, 4b, 5b): The insect infestations with the most serious potential impact on caribou are in the south Selkirks and the central Monashees. In the south Selkirks, spruce beetle outbreaks on both sides of the border have resulted in accelerated logging in known caribou ranges. Trap tree programs have been attempted, but have failed to curio insect populations. In some key habitats, such as the Summit Creek drainage, salvage logging has been limited to the removal of infested and susceptible spruce (R. Neil, pers. comm.).

The largest spruce beetle infestation in the Kootenays in 1982 was in the Pingston Creek area, where 3500 ha were attacked. This infestation is expected to be reduced by 1984, because of host depletion (Wood and Van Sickle 1983). The beetle-attacked areas lie within suspected caribou habitat, and it seems likely that the animals will be affected by additional logging in this area.

In the north Rockies, outbreaks of mountain pine beetle are numerous along the east side of Kinbasket Lake, but the potential impact of accelerated logging in that area is unknown. In the Purcells and the central Selkirks, spruce beetle infestations are small and local. No infestations have been identified in the northern Selkirks and Monashees.

Other developments and human activities: Hydroelectric developments have affected every major river valley in the Kootenays. The Duncan Dam, completed in 1967, flooded the Duncan Valley almost to the mouth of East Creek. In autumn of that year, a drowned caribou was seen in the newly-created reservoir (No. 109 in Vol. 2, Appendix 1, Region 4 [Caribou sightings]). According to local residents (J. Harling, unpubl. data), large numbers of caribou were shot

every fall in the early 1900's in the meadows north of Howser Lake. In the 1950's and 1960's, small numbers of caribou were seen regularly in that area during fall. Since 1967, few caribou have been seen south of East Creek. These observations suggest that the Duncan Dam caused the flooding of a traditionally used habitat, although the population using it may have been reduced in numbers before the dam was built.

The Hugh Keenleyside Dam at Castlegar caused the flooding of the Arrow Lakes in about 1969, and may have affected the movement of caribou between the central Monashees and the central Selkirks. According to A. Frisby (pers. comm.), caribou formerly crossed the Columbia River at Wigwam, a location that is now flooded.

Kinbasket Lake was created in 1974 by the Mica Dam. Drowned caribou were reported by B.C. Hydro personnel at the time of the initial flooding. Before the flooding, residents observed caribou crossing the Columbia at traditional locations. It is not known whether any of these crossings are still used (Russell et al. 1982).

The Revelstoke Dam, completed in October 1983, flooded the Columbia Valley to the 570 m level between Revelstoke and Mica. The possible impact of the flooding on caribou is under investigation by K. Simpson, under contract to the Fish and Wildlife Branch.

Prospecting and mining have been going on in the Kootenays since the late 19th century. These activities have affected caribou by introducing people, trails and roads into remote areas. The impact on caribou of habitat destruction due to mining has probably been minimal.

The mountain ranges in the Kootenays have a high value for recreation; hiking, cross-country skiing, heliskiing, and snowmobiling occur within caribou ranges. Snowmobiling is a problem in the Salmo-Creston area (International Mountain Caribou Technical Committee files) and the Revelstoke area. Proposed heliskiing developments are currently a concern of wildlife managers. Several proposed developments would affect caribou ranges. At present, the Fish and Wildlife Branch is preparing a position paper on heliskiing (A. Soobotin, pers. comm.), and the impact of snowmobile use on caribou is under investigation by K. Simpson.

Status of habitat in caribou ranges

As in the Kamloops Region, most caribou ranges in the Kootenays have sustained relatively large amounts of disturbance from fire and logging (Fig. 6). Of the identified high-elevation ranges, only Mount Carson and Mystic Mountain are unaffected by logging. Those two small ranges, located on the boundary of Glacier National Park, are composed almost entirely of alpine and alpine forest; the boundaries of those ranges should probably extend to lower elevations, but we had no basis for redrawing them. The other high-elevation ranges (No's. 1,2,4,5,6,9, and 14) include substantial components of spruce - balsam forest as well as alpine types. The high-elevation ranges that have sustained the largest amounts of habitat disturbance from fire and logging are Salmo-Creston, Mount Skelly, and Corbin Pass, all of which have 30% or more of the area in immature types (IM, NSR, DSD).

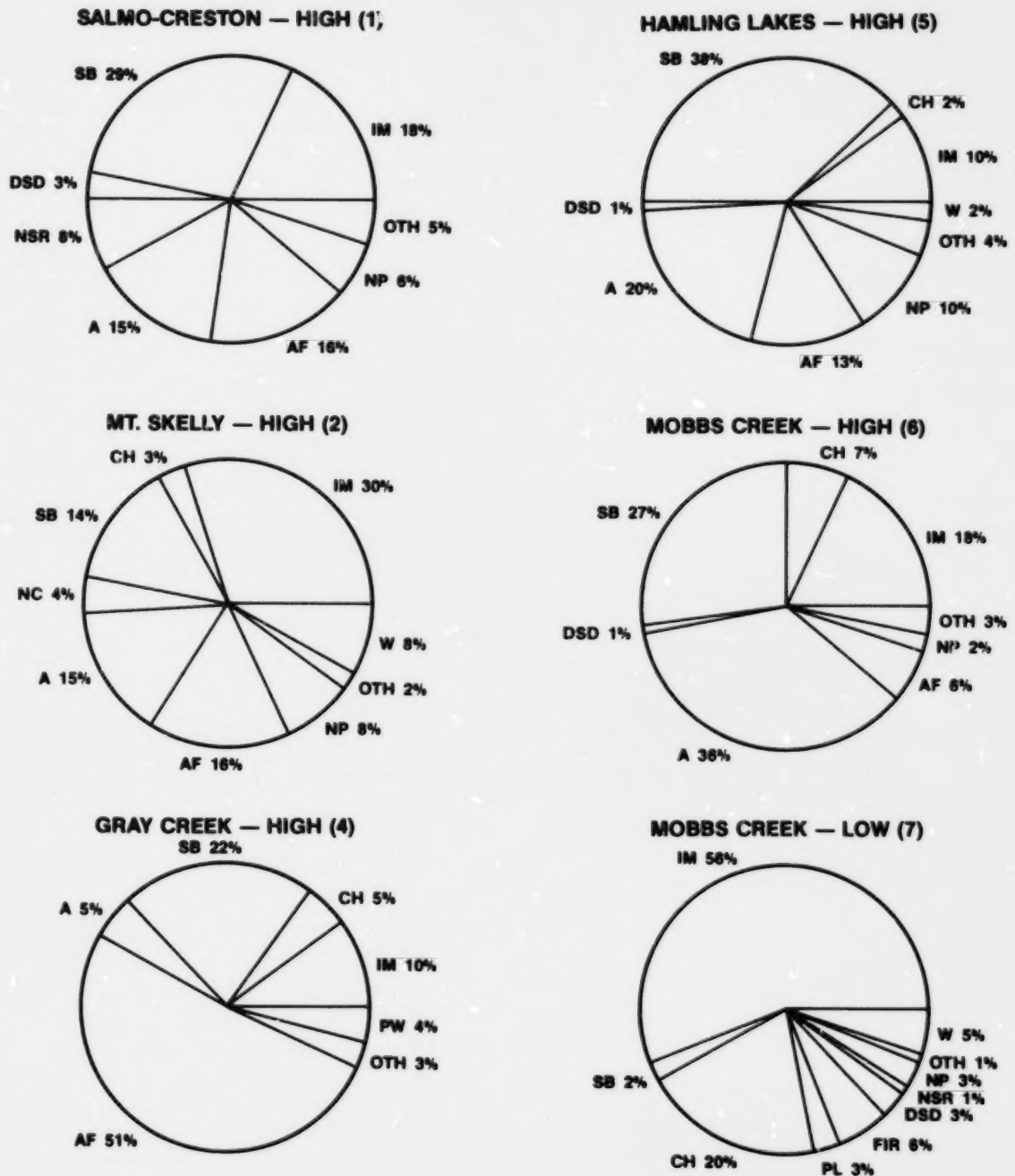
Only three low-elevation ranges were identified: Mobbs Creek-low, Kirkup, and Frisby Ridge-low. The low-elevation range at Mobbs Creek stands out as having a particularly large immature component, probably due to a long history of logging as well as to fire.

Inventory data were unavailable for large areas in the Kootenay Forest Region. The large caribou range that includes Grassy and Old Baldy Mountains in the southern Purcells is included in the Mark IV system, but the data were not available in a usable form. The Columbia valley north of Revelstoke (including the northern half of Frisby Ridge), the Pingston Lake area, and parts of the central Selkirk are in TFL 23. The northern part of the Salmo-Creston range is in Tree Farm 40. Inventory data are also unavailable for the caribou ranges in Glacier National Park.

Forest management planning

At least six of the seven TSA's in the Kootenay Forest Region support some caribou. The Kootenay Lake TSA includes parts of the north and south Purcells, and the south and central Selkirks. The Cranbrook TSA includes the rest of the caribou habitat in the south Purcells. The remainder of the south and central Selkirks and part of the central Monashees are within the Arrow TSA. The Revelstoke TSA includes the rest of the central Monashees, the north Monashees and most of the north Selkirks. The north Rockies and the rest of

FIGURE 6. Status of habitat in caribou ranges: Region 4.

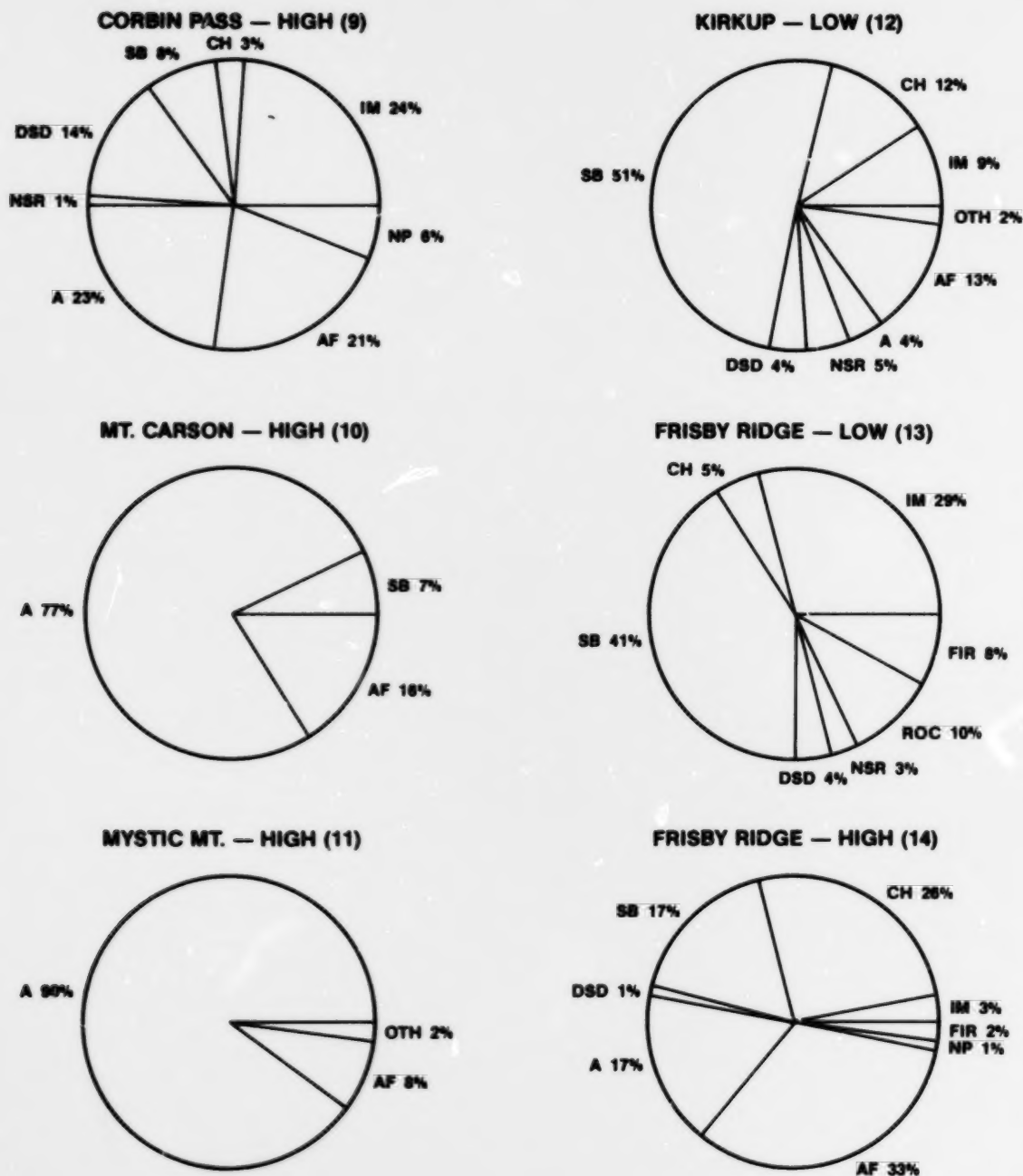


LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

FIGURE 6. Status of habitat in caribou ranges: Region 4 (continued).



LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-beam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

the north Selkirks are in the Golden TSA. Caribou have occasionally been seen in that part of the north Purcells included in the Invermere TSA. If Russell et al. (1982) are correct about a relict population near the headwaters of the Kettle and Granby rivers, then there may be caribou in the Boundary TSA. Only the first five TSA's, which contain substantial areas of caribou habitat, are treated here (Table 1).

The Kootenay Lake TSA is composed of the Creston and the Lardeau PSYU's. The Creston PSYU, which includes the south Selkirks and the south Purcells, is experiencing a short-term timber supply deficit. Results of the yield analysis (Nelson Forest Region 1980) indicate that the 20-year commitment in the Creston PSYU cannot be maintained, but the 20-year commitment in the Lardeau PSYU is adequate. Overall, the 20-year commitment in the TSA can be met by making up the shortfall in the Creston PSYU from the surplus in the Lardeau PSYU (Table 1). Falldown to the Long Run Sustained Yield Level is anticipated after 120 years (B.C. Ministry of Forests 1983). According to the yield analysis report, falldown will be insignificant because of the high proportion of immature timber in the TSA.

The AAC for the TSA was set at 900 000 m³, which is lower than the previous AAC (Allowable Annual Cut Determination, Kootenay Lake Timber Supply Area, 13 March 1981). This level of cut may require the relocation of some industrial operations to reduce the concentration of harvesting. A further reduction in AAC is anticipated if the forest industry is unable to harvest timber in an acceptable manner on steep slopes and in areas currently considered inaccessible.

The 1981 AAC continued the policy of protecting the international caribou herd by reserving some caribou habitat in the south Selkirks from harvesting. The timber harvest foregone by continuing this policy was calculated at 26 928 m³ annually, or approximately 3% of the AAC (Nelson Forest Region 1980). The harvesting policy within caribou habitat is to apply a cut/leave ratio within compartments of 20/80, rather than the usual ratio of 40/60 (H. Nyst, pers. comm.). This constraint applies within areas identified by Freddy (1974c and unpubl. maps) as important habitat. Currently, the cut/leave constraint is being exceeded in some compartments because of spruce beetle attacks (J. Sedlack, pers. comm.).

The Cranbrook TSA is experiencing a short-term timber supply deficit, due to inaccessibility and to management constraints -- cut/leave ratios and delay periods (Nelson Forest Region 1981b). The 1981 AAC of 900 000 m³ (Allowable Annual Cut Determination, Cranbrook Timber Supply Area, 15 December 1981) represents a reduction from the previous commitment. However, harvesting rates will be permitted to exceed this level in the first 5-year period if accelerated cutting is necessary to use dead timber resulting from insect attacks. Mountain pine beetle infestations are a serious problem in parts of the TSA that are not caribou habitat. In the future, pressure to alleviate the short-term supply shortage by relaxing management constraints could affect rates and patterns of harvest within caribou habitat.

The long-term analysis of the timber supply (B.C. Ministry of Forests 1983) shows that the present AAC can be maintained throughout a 200-year look-ahead period. However, the long-term timber supply could be affected by the loss of mature pine volume to mountain pine beetle (Nelson Forest Region 1981b).

The Yield Analysis Report for the Arrow TSA (Nelson Forest Region 1981a) reveals a potential shortfall in the timber supply during the second 5-year period of the short-term. The shortage is caused by the delay between the first and second pass harvests in some watersheds. The removal of the Valhalla Wilderness Area from the forest land base will further increase the difficulty of obtaining short-term supplies.

The long-term yield analysis (B.C. Ministry of Forests 1983) indicates that the present commitment level can be maintained throughout the 200-year look-ahead period.

The 1981 AAC was set at 640 000 m³ (Allowable Annual Cut Determination, Arrow Timber Supply Area, 12 June 1981), a reduction from the previous commitment. That level of harvest assumed an improvement in industry's ability to harvest and reforest steep slopes and areas of difficult access. The AAC was subject to early revision in response to future management decisions concerning the Slocan Valley Planning Area. As of June 1983, that study is still in progress. Following the creation of the Valhalla Wilderness Area on February 16, 1983, the AAC for the Arrow TSA was reduced to 619 000 m³ (K. Milner, pers. comm.).

Much of the Revelstoke TSA consists of TFL 23, which is managed separately and is not included in the analysis. Areas of caribou habitat covered by the analysis are primarily those in the Jordan and Tangier river drainages, and in the vicinity of Mica Dam.

The Revelstoke TSA has an available short-term supply of timber in excess of the commitment level at the time of the Yield Analysis Report (Nelson Forest Region 1981d). Most of that volume is in mature and overmature timber. The updated long-term analysis (B.C. Ministry of Forests 1983) indicates a falldown to below the Long Run Sustained Yield level after 120-130 years. The AAC of 130 000 m³ that was determined in 1981 (Allowable Annual Cut Determination, Revelstoke Timber Supply Area, June 12, 1981) was an increase over the previous AAC, and represents a management decision to minimize the loss of overmature timber to insect attack, fire, disease and windthrow.

The Golden TSA is similar to the Revelstoke TSA in that most of the available volume is in overmature stands (Nelson Forest Region 1981c). The short-term supply is adequate, but the long-term analysis (B.C. Ministry of Forests 1983) indicates a falldown of 30% beginning after 50 years. The 1981 AAC of 650 000 (Allowable Annual Cut Determination, Golden Timber Supply Area, 12 June 1981) is slightly reduced from the previous level. Continuation of this level of harvest in the short-term requires that access is improved, steep slopes are harvested and reforested, and some old-growth hemlock is utilized. The Golden TSA has the additional problem of mountain pine beetle infestations, which could further reduce time to falldown. Because of the substantial anticipated falldown effect in this TSA, there is considerable pressure to expand the timber supply by harvesting problem forest types (especially old-growth hemlock), improving utilization, and practising intensive forestry.

Habitat protection

Habitat protection for caribou in the Kootenay Region has been most intensive in the range of the International Boundary Herd in the south Selkirks. In that area, the Fish and Wildlife Branch and the Ministry of Forests have co-operated to sponsor research and to develop habitat protection policies. The International Mountain Caribou Technical Committee, composed of

government, industry, university, and citizens groups from both sides of the border, has also had a role in habitat protection.

In 1974, as a consultant to the Forest Service, Freddy applied the findings from his thesis research (Freddy 1974a) to forest management in caribou habitat. He mapped areas of caribou use and prepared general recommendations for harvesting in caribou habitat (Freddy 1974b), as well as management recommendations for specific drainages (Freddy 1974c). That work became the basis for the timber reserve for caribou in the Kootenay Lake TSA, which was continued in the 1981 AAC Determination (J. Sedlack, pers. comm.).

In the south Selkirks, Fish and Wildlife and Ministry of Forests staff have experimented with selective logging prescriptions for timber harvesting in caribou habitat. Initially, diameter limit prescriptions were designed to remove 40-50% of the stems, but the remaining trees tended to blow down. Later, modified prescriptions were developed, based on that experience and on Stevensons's (1979) data on distribution of lichen in Engelmann spruce - subalpine fir stands. The new prescriptions were site-specific and combined diameter limit guidelines with faller's judgment. Blowdown has also been a problem on some of these sites (H. Nyst, pers. comm.).

At present, harvesting in south Selkirk caribou habitat is aimed at salvage logging of stands infested by spruce beetles. Site-specific prescriptions are developed which depend on intensity of attack and importance of the area to caribou (A. Soobotin, pers. comm.).

Elsewhere in the Kootenays, habitat protection recommendations for caribou include adjustment of size and location of cutblocks, and selective logging. Selective logging is recommended particularly in high-elevation, closed-canopy Engelmann spruce - subalpine fir stands where it is justified by a combination of resource values, such as watershed protection or habitat protection for other species (A. Soobotin, D. Martin, pers. comm.).

The mission of the International Mountain Caribou Technical Committee is to provide an avenue for the dissemination of information that will ensure sound caribou management. The committee monitors the status of the animals and of developments that affect them, and has published guidelines for human activity within the range of the animals (Johnson et al. 1977, 1981). In the past, the committee acted as an informal advisory body to the agencies that study and manage the animals. Since 1982, the Technical Committee has had the

function of making recommendations to the Selkirk Caribou Steering Group. The Steering Group is composed of one representative each of the seven United States and British Columbia agencies that are directly involved in managing the caribou. Its function is to co-ordinate the management programs of the co-operating agencies.

Woodland caribou have been declared endangered in Idaho and Washington, and in February 1984 the U.S. Department of Interior placed woodland caribou on the national endangered species list. The listing of caribou as an endangered species is likely to cause changes in habitat management in the United States.

2.4.3 Information needs

Seasonal ranges are fairly well known where caribou studies have occurred, but are unknown or poorly known elsewhere. Little is known of calving or rutting areas. There is an apparent difference in habitat use between the south Selkirks, where little seasonal shift in elevation is reported, and the rest of the region, where elevational movements are similar to those reported in the Kamloops region. It is unclear whether caribou in the south Selkirks actually behave differently, or whether the apparent difference is an artifact of study methods and opportunities for observation.

Because augmentation of the south Selkirk caribou population has been proposed, there is a special need for information on the methods and possible effects of a transplant. Information on transplant methods is available in the literature, but an evaluation of the adequacy of the proposed habitat in the United States is needed. Research needs in the south Selkirks have been summarized by many, most recently by Neil (1980a and 1980b) and Scott (1982). A problem analysis is currently in preparation by a committee of the Caribou Steering Group.

2.4.4 Information base

Aerial surveys

CLI

82F: 2/5&17/68

82K: 2/68

82L: 1&2/68

82M: 2&3/68, 1&2/70

82N: 1&2/68

Incidental sightings: About 250. Mostly compiled by Notre Dame University caribou research project staff, and by D. Johnson, International Mountain Caribou Technical Committee. For sightings of Selkirk caribou prior to 1974, see Freddy (1974a).

Fish and Wildlife Branch studies and reports

Revelstoke Wildlife Program 1980 to present. Principal investigator:
K. Simpson.

Objectives: Determine the preferred seasonal habitats of caribou; determine the comparative use of disturbed versus undisturbed areas; determine seasonal food habits and relate them to habitat selection.

Major activities: Radiotelemetry, fecal fragment analysis, arboreal lichen sampling and growth rate estimates, habitat classification and analysis of caribou use in relation to availability, population estimates and management recommendations.

Reports: Simpson and Hebert (1982); Simpson et al. (1984a; 1984b). Russell et al. (1982) - Regional review of existing information on distribution and abundance, harvest data, and biology of caribou; management and protection plan. Preliminary draft based on studies carried out in 1975. Ministry of Forests studies and reports

Freddy (1974b) - Description of caribou habitat in southern Selkirks and Purcells; guidelines for logging in drainages containing caribou habitat.

Freddy (1974c) - Recommendations concerning future areas of timber harvest within the range of caribou in the south Selkirks.

Stevenson (1979) - Study of the short-term effects of selective logging according to various prescriptions on the supply of arboreal lichens available to caribou.

Yule (1979) - Visual estimates were used to inventory arboreal lichen abundance in several forest cover types and drainages in the south Selkirks.

Neil (1980a) - Summary of variables and information needs relevant to timber harvesting development plans in a portion of the south Selkirk caribou range.

Neil (1980b) - Proposal for research to meet information needs described by Neil (1980a).

Parks Canada Studies and reports

Mountain goat and mountain caribou study 1977-1979. Principal investigator: W. McCrory.

Objectives: Collect reconnaissance data on caribou in preparation for a later, more detailed, study.

Major activities: Ground observations, habitat descriptions.

Reports: McCrory and Holland (1977); McCrory (1978, 1979).

Van Tighem et al. (1982) - Summary of existing information on status, distribution, and seasonal habitat use in Mount Revelstoke and Glacier National Parks, and comments on management considerations.

Idaho Department of Fish and Game study 1982 to present.

Principal investigator: M. Scott.

Objectives: For caribou in the south Selkirk Mountains, to determine present population status (including degree of genetic isolation), distribution, and seasonal food and habitat preferences; to describe social relationships; to evaluate desirability and feasibility of population augmentation; and to update guidelines for human activity.

Major activities: Ground tracking of caribou fitted with motion-mortality radiocollars, genetic analysis of blood and/or tissue samples, collection of snow and habitat data, estimation of forage availability, observations of feeding and of social behaviour.

Reports: Scott (1982, 1983).

University of Idaho studies

Lichen biomass study 1972-1974. Principal investigator: G. Schroeder.

Objectives: Quantification of arboreal lichen abundance in a variety of habitat types throughout the range of caribou in the south Selkirks.

Major activities: Intensive sampling of arboreal lichen biomass; incidental caribou observations.

Project discontinued before completion.

Reports: Schroeder (1974) and progress reports.

Status and management of the Selkirk caribou herd 1971.

Principal investigator: D. Freddy.

Objectives: To determine the abundance, composition, distribution, and movements of the caribou, and to prepare management recommendations.

Major activities: Ground surveys, aerial surveys.

Reports: Freddy (1974a, 1979); Freddy and Erickson (1975).

Yeo (1977a, 1977b) - Descriptions of vegetation in several areas of caribou use in the south Selkirks, and classification according to the habitat type system of Daubenmire and Daubenmire (1968).

Johnson (1976) - Description of existing and proposed developments within caribou habitat in the Salmo-Creston summit area.

Johnson and Todd (1977) - Caribou use of a highway crossing was monitored with a time-lapse camera.

Johnson and Miller (1979) - Notes on recruitment, rutting behaviour, antler development and loss, and calf mortality among Selkirk caribou, based on incidental observations.

Johnson and Feldman (1979) - Map of potential caribou habitat in northern Idaho and Washington. Forest habitat types having characteristics considered important to caribou were selected by computer.

Van Daele and Johnson (1983) - Estimates of arboreal lichen abundance based on biomass sampling in five plots in southern British Columbia and northern Idaho.

Notre Dame University of Nelson, Caribou Research Project 1974-75.

Principal investigators: J. Harling, J. Snyder.

Objectives: To define seasonal habitat use and movements of caribou in the Kuskanax- Lardeau region, to determine population size and composition, investigate behaviour, identify habitat requirements and tolerance levels for human disturbance, determine optimum environmental conditions for the growth of forage lichens, and develop guidelines for land management practices conducive to caribou survival.

Major activities: Ground and aerial surveys, interviews with local residents, behavioural observations, photographic recording and analysis, vegetation sampling in feeding areas, laboratory studies of lichen growth rates in relation to light and temperature. Project terminated prior to completion due to the closure of Notre Dame University.

Reports: A substantial amount of data is on file with the principal investigators, but no reports have been completed.

International Mountain Caribou Technical Committee files 1971 to present.

The major function of this group is to promote sound management programs for caribou in the southern Selkirks and to co-ordinate existing knowledge into management recommendations. The committee monitors information on the animals and on habitat changes within their range.

Reports: Johnson, Miller and Peek (1977, 1981).

Miscellaneous reports

Munro (1945) - Report on birds and mammals of Glacier National Park, including several paragraphs on distribution and abundance of caribou.

Evans (1964) - General review of the history and status of caribou and their habitat in Idaho, Washington, and Montana.

Herbison (1973) - Report on observations of caribou by local residents and by the author in the northern Kootenay Lake area.

Layser (1974) - Compilation of existing information on history, biology, and habitat of caribou in Washington and Idaho.

- Hamer (1974) - Study of distribution, seasonal movements, and abundance of caribou in Glacier National Park, with management recommendations.
- Carlton (1982) - Study of habitat use, movements, and herd composition of caribou in the south Selkirks.
- Jerry (1982) - Discussion of old-growth management in the Idaho Panhandle National Forests; includes calculation of minimum viable population size for southern Selkirk caribou.

2.5 Caribou Forest Region - Fish and Wildlife Region 5: Quesnel Highland

2.5.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Maps 7a, 8a, 8b): Caribou occur along the eastern boundary of the region from Bowron Lake Park and Barkerville in the north to Hendrix Lake in the south. They are continuous with the Wells Gray Park caribou on the east, and the Yellowhead Highway caribou on the north.

Historic changes in distribution: At McKinley Lake, Bosk Lake, and Club Creek, caribou were common in the 1920's, but apparently disappeared in the mid 1930's. Hunting was insignificant, fires were not widespread, and there was no logging (Russell and Russell 1976a).

On the plateau between Moffatt Creek and Horsefly River, and in the Mount Hendrix area, caribou have not been recorded since the 1969-71 CLI flights. On Big Timothy Mountain, caribou are reduced or absent, probably due to disturbance by snowmobilers (M. Beets, pers. comm.). Logging and road development have occurred in all those areas.

Numbers, status and management: The few data existing on caribou numbers and distribution in the Quesnel Highland have already been intensively reviewed during the course of studies by Fish and Wildlife Habitat Protection staff in Williams Lake. At the project proposal stage, Russell (1975) stated that for most of the area, caribou density, distribution and movements were poorly known, and one of the major objectives was to obtain information on those aspects. In consideration of that job, he noted that "It may require substantial time to develop a reasonable census method..." (Russell 1975:4).

The subject was pursued further in Beets and Russell (1976c), to the extent of describing census techniques used elsewhere and selecting a stratified random sampling technique they felt merited consideration. Apparently, however, they did not have the opportunity to test that or any other system during the course of their work.

For the purposes of a draft management plan (B.C. Ministry of Environment, Fish and Wildlife Branch 1980a), a Quesnel Highland population of 235 animals, of which 55 were designated as "shared" with adjacent regions, has been estimated. The origin and nature of these numbers in relation to documented observations (see Appendix 1) is unclear, but it appears that a significant component of "professional judgement" is involved. The above estimate is the sum of separate estimates for 14 "inventory blocks" established in the Quesnel Highland area by Young and Beets (1980). Those estimates are listed and discussed in following paragraphs on the three GMU's in the area:

1. GMU 5-2A: (All or most of Cottonwood, Black, Hendrix and Bowers inventory blocks), estimate of 0 animals.

It is implied that regular occupation of these units by caribou is not now suspected to occur. Historical information is vague, but occasional comments in the "Report of the Provincial Warden" with reference to the Quesnel/Williams Lake area probably apply. Those are purely qualitative, indicating animals were "plentiful" in 1929, "holding their own" in 1934, but "not as plentiful" on the Dragon Mountain Range as in the past (said to have occurred there in "large herds" in 1850, i.e. pre-settlement). In 1938 the term "scarce" was applied to caribou in the area, and there are no indications of recovery or abundance since.

We have only two records involving numbers for the past 20 years, eight animals on Big Timothy Mountain in winter 1969, and eight others west of Keithley Creek on 22 March 1979. The latter was one of five observations involving 35 animals seen north of Quesnel Lake on that day. Tracks have been seen in 5-2A on other occasions, usually in winter and certainly reflecting movements from more regularly used ranges to the east.

2. GMU 5-16 - (Inventory block "Bowron", comprising all of Bowron Lake Park), 5 animals.

Apparently there have been several observations of caribou and/or sign in Bowron Lake Park, but details on animal numbers have not been included in park records. Owing to the nature of most human occurrence in the park, all observations have been along the waterways. The actual seasonal distribution of caribou and the nature of their use of habitats in the general Bowron area is not known, nor can it be inferred from data in hand. The single observation among our records in which a number was specified, involved a sighting of five animals at Lanezi Lake in July 1982.

3. GMU. 5-15A - (all remaining inventory blocks, including portions of Cottonwood, Black and Hendrix units), 230 animals.

Clearly the primary caribou occurrence in the Quesnel Highland is in this very large unit. Appendix 1 lists maximum counts applicable to the entire area since the early sixties. Following is a more area-specific summary, with historical references from Report of the Provincial Warden (RPW), 1905-1956, and the recent sightings summarized in Appendix 1. Again, the inventory blocks of Young and Beets (1980) are the local area designations and the estimates for each (B.C. Ministry of Environment, Fish and Wildlife Branch 1980a) serve as status statements for discussion.

Willow (0 animals) and Roundtop (30): Those two blocks comprise the general Wells/Barkerville area (east of Bowron). Early mention of caribou in the area (RPW) include "good reports" in 1918, "numerous" in 1932, and "doing well" in 1936. However, as in the Bowron block, reports were more pessimistic in following years, with no evidence of significant recovery to the present. Although the population estimate for the northernmost block (Willow) is 0, there have been records of occurrence there in recent years, virtually all in the western portion.

The largest count in the Quesnel Highlands area in the past two decades was an observation of 48 in two groups on Yanks Peak in late May 1961. There have been no subsequent records approaching that number. Two groups totalling 10 animals were seen in the Roundtop Mountain area in April 1974, eight were found west of Keithley Creek in late March 1979, and sign has occasionally

been seen at scattered locations in the area into the early 1980's. In short, caribou appear to visit the area regularly, mostly in winter judging from the records, but there is little evidence to support the estimate of 30 for the Roundtop Block except in a sense of possible occasional concentrations of animals from elsewhere.

Spanish (0) and Stevenson (50): The inventory block in the Spanish Mountain area is very small, less than half the size of the next smallest unit in this series. That, plus the fact that we have no records of sightings there, lend support to the zero estimate. However, animals have been recorded on Mount Brew (13 in April 1974 and eight in March 1979), which is only 8-9 km away. Occasional excursions into the unit probably occur.

The 50 animals estimated for the Stevenson Block is the second largest among the 14 inventory blocks. The only historical reference that may be referable to the area is one from RPW (1955), which states that the small bands in places such as Quesnel Lake "appear to be holding their own." As usual, there are no numbers from the early years to serve as baseline figures and few recent observations to assist in determination of current numbers or population trend. The observations from Mount Brew (above), pertain; there are several other observations for that area, west of the North Arm, but not cumulative series over a short time period that would support the estimate of 50. Again, most observations are in winter, at which time animals might be able to move more freely across frozen rivers and lakes from points east. There is a chance that the 50 assigned to Stevenson may at least partly duplicate those assigned to Niagara, the adjacent unit to the east and, as will be shown, the Quesnel Highland inventory block with the highest estimated population.

Unregulated (15) and Gnost (15): Tracks, but no other observations, have been recorded in both blocks. The 15 animals in the Unregulated block are considered to be shared with Region 7, while those in Gnost are assigned strictly to Region 5. In fact, distances in the area are so small in caribou terms (30-40 km), that there is a good chance that the caribou which occur in both units also occur at least occasionally both in Region 7 and in Region 3.

Niagara (65), Horsefly (40) and Deception (15): Although all three units flank the western boundary of Wells Gray Park, only the Horsefly block is considered to have animals in common with Region 3 (B.C. Ministry of Environment, Fish and Wildlife Branch 1980a). Actually, all three probably share animals with Wells Gray Park and with each other at least occasionally. There is some evidence that occurrence in these eastern units may be similar to that in Wells Gray, including extensive spring and perhaps summer use. Guide reports on animals seen during spring bear hunting season in the early 1970's (Russell and Russell 1976a), suggest numbers at that time which approach or exceed the official estimates, e.g. groups of 25-50 in the Roaring River area (Niagara Block) and 67 in the Eureka Basins (Horsefly Block). Note that the animals of the above observations may have spent the summers in or near the locations named, but many might also have been enroute to summer ground farther east.

Most documented sightings in those blocks, especially in recent years, are less encouraging than those from the guide reports. The highest cumulative total in Niagara since August 1961, when a geological survey team reported "bands of 12-28", was a group of 12+ animals on the North Arm of Quesnel Lake in January of the following year. The only other sightings, other than occasional tracks, were of five and eight animals, respectively, in January and March of 1979. The Horsefly block fares little better: 14 animals plus scattered tracks in five locations on 18 April 1974 and 11 in two locations, March 1979. At Deception, 10 animals in two groups were seen in June 1961, and the largest short-term total since then was six, all on Boss Mountain in March 1978.

Consideration of caribou populations in the Quesnel Highland and adjacent areas of Regions 3 and 7 illustrates the likelihood that the whole, in caribou management, is not necessarily the sum of its parts. Most of the data for the area are scattered in time and space, so that it is rarely possible to demonstrate that the current count in area B is not a duplication of animals counted at another time in area A. The problem potentially exists in the counts and estimates for most of the 14 inventory blocks discussed above. However, the most glaring example in the present context is the potential duplication between the Wells Gray Park area, which is surveyed in summer, and

the adjacent Quesnel Highlands where most observations in which animals were counted have been in winter.

Bergerud (1978:23) considered a previous Fish and Wildlife estimate of 300 to be too high, "... based on the few sightings ... and the small size of the aggregations seen". He proposed "possibly 200" as an alternative figure and produced data suggesting that the population was declining. The largest short-term cumulative count in the Quesnel Highland in the past decade has been 35 animals, distributed over five of the 14 inventory blocks on 22 March 1979. That is weak support for the current estimate of 235, not even equalling the component (55) designated as "shared" with adjacent regions. That number may be valid as a statement of population in terms of habitat protection needs, considering possible seasonal influx of animals from elsewhere, but is probably not for such purposes as calculation of harvest rates or quota allocations.

As with most of the areas of central/southern British Columbia considered in this study, there was a caribou hunting closure in effect in the Quesnel Highlands from the mid-forties through the mid-fifties. A short (3-week) hunting season was established in 1956, but in all subsequent years through 1974, season lengths were 60-100 days in duration. The longest seasons were in the period 1960-1971 (Vol. 2, Appendix 4), during which time either-sex regulations applied. Only males have been legal game in the area since 1972.

With the introduction of GMU's in 1975, it became possible to regulate different portions of the area separately. At that time GMU's 5-2A and 5-16 were closed; 5-15A has remained open through 1982, with season lengths gradually decreasing from about 2 months in 1975-79, to 7 weeks in 1980, to 6 weeks in 1981-82.

Table 5 shows harvest statistics for the Quesnel Highlands from 1964-1981. Hunter Sample figures, which Mitchell (1978) indicates are too high in an absolute sense, show a general trend toward decreasing numbers of both hunters and kill over that period. Since we know little about population trend during the two decades indicated, it is difficult to determine whether decreasing supply or increasing restrictions were the more important in determining the observed trends in hunter participation and success. The first dramatic dip in hunter numbers came in 1972, the first year of the males-only regulation, and the estimated kill in that year was less than 20%

TABLE 5. Harvest statistics for caribou in the Quesnel Highland area, Region 5, 1964-1981. Number of resident hunters, resident kill, and hunter success are estimates (Hunter Sample, B.C. Fish and Wildlife Branch, Victoria, B.C.)

Year	Hunter Sample Results				Compulsory Inspection Results				
	No. res. hunters	Res. kill	Hunter success (%)	Percent male(N) ^a	Guided kill ^b	Res. kill	Non-res. kill	Total	Mean age(N)
1964	154	15	10	50(8)	-				
1965	113	11	10	67(6)	8				
1966	100	15	15	75(8)	24				
1967	75	15	20	33(6)	7				
1968	81	10	13	75(4)	-				
1969	56	7	13	0(2)	-				
1970	63	9	14	75(4)	8				
1971	57	17	29	-	-				
1972	29	3	10	100(1)	-				
1973	66	11	17	100(2)	-				
1974	17	8	47	100(2)	4				
1975	52	18	35	100(8)	-				
1976	48	8	17	100 ^c	-				
1977	50	10	20	100 ^c	-				
1978	24	4	17	100 ^c	-	4	3	7	5.0(6)
1979	29	2	7	100 ^c	-	3	0	3	5.0(3)
1980	23+	0	0	-	-	2	1	3	4.3(3)
1981	36	5	14	100 ^c	-	4	0	4	6.0(4)

^aReported kill, by sex, in Hunter Sample.

^bAs specified in Hunter Sample; guided hunters included residents over most of 1960's and early 1970's.

^cAssumed, since season open to males only.

of what it had been in 1971. For those years in which the open season pertained to all three GMU's (5-2, 5-15 and 5-16, managed together as MA 19), the mean estimated kill was 12.4 under either-sex regulations (1964-1971) and 7.3 during bulls-only years (1972-1974).

Interestingly, the highest estimated resident kill during the period (18), came in 1975, the first year of closure in GMU's 5-2 and 5-16. Whether hunters actually stopped hunting in those units then is not known, but estimated kills of 4 and 2 were projected for GMU 5-2 in Hunter Sample data summaries for 1976 and 1977, respectively.

The few guided kill figures in Table 5 are from separate tables in Hunter Sample volumes for the years indicated. Bergerud (1978) produced figures for the years 1969-1976, but those for 1970 and 1974 do not agree with those in Table 5, and he did not name his source. Whatever the true figures might be, it is important to note that those in the years prior to about 1975 include kills by residents as well as non-residents. Thus the Hunter Sample estimates and recorded guide kill figures are not additive.

Hunter Sample estimates and compulsory inspection results are fairly close for recent years. The latter indicate an average kill (resident and non-resident) of about four animals per year (1978-1981). Applied to the recent population estimate of about 180 animals designated as present in the Quesnel Highlands and not shared with adjoining regions (B.C. Ministry of Environment, Fish and Wildlife Branch 1980a), a harvest rate of about 2.2% is indicated. However, the rate is of course higher if the fall population is actually smaller than that estimated and is lower if the rest of the Wells Gray population, now mostly closed to hunting, is included in calculations.

2.5.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Maps 7a, 8a): Late winter ranges are fairly well known. Subalpine and timberline forests are used. The primary forage is arboreal lichens, though cratering has been observed (Russell and Russell 1976b). Caribou also use windswept ridges, where dried grasses, sedges, forbs, and perhaps terrestrial lichens are available (M. Beets, pers. comm.).

Spring: There are few documented observations, but guides report use of slides (Russell and Russell 1976a).

Calving areas: Unknown.

Summer: Summer ranges are not well documented. Russell and Russell (1976b) noted that caribou used the alpine mainly in early summer, when snow was still present on north aspects. Later, they used small wet meadows and adjacent forests in subalpine cirque basins. In the Quesnel Highland, snow patches are often gone by mid-August (T. Smith, pers. comm.); in the absence of summer snow patches, caribou may require timber for thermoregulation or insect relief. Russell and Russell (1976b) also reported extensive use during late summer and early fall of a large, suboxic 50-60 year old burn.

Rutting areas: Little is known about rutting areas. Most guides reported that caribou rut in timber (Russell and Russell 1976a).

Fall/early winter (Vol. 2, Maps 7a, 8a): Some early winter ranges have been identified. Low and mid-elevation lodgepole pine and probably cedar - hemlock forests are used.

Movement routes and special habitats: Several movement routes and two licks have been mapped (Vol. 2, Maps 7a, 8a).

Factors affecting caribou habitat

Logging: Early logging in the Quesnel Highland was concentrated at low elevations. Typically, the valuable spruce and Douglas-fir stems were removed, and cedar and hemlock were left. Cut-and-leave strips were used in parts of the region, but nearly all the leave strips have since blown down or been logged. Most seed blocks, which were commonly left before about 1970, have likewise been removed. According to Timber Officer M. Carlson, the blowdown problem in the Quesnel Highland is probably the worst in the province, making harvesting systems such as these unfeasible. Thus, regardless of early logging history, most harvested areas have ended up as clearcuts.

Much of the logging in the Quesnel Highland has taken place since the advent of close utilization standards. Since that time, the usual prescription for harvesting and silviculture in the ESSF zone, as well as the ICH zone, has been clearcut logging, slashburning, and planting. Mechanical site preparation is an alternative to broadcast burning, but it is not feasible on steep or sensitive sites. In many areas, site preparation has not been kept current, because forest protection considerations have limited the number of days each year that burning is done. Planting on unburned sites reduces survival and growth, especially in the ICH zone, where there is usually more debris than in the ESSF zone. As lack of site preparation is the major silvicultural problem in the Quesnel Highland, an extended burning period is under consideration (Y. Yano, pers. comm.)

The major species planted in the Quesnel Highland are spruce and Douglas-fir in the ICH zone, and spruce in the ESSF zone. From about 1975 to 1980, due to a shortage of spruce seedlings, an effort was made to preserve balsam residuals; this is not done currently. Brush competition is not considered a major problem in the Quesnel Highland, though brush control is carried out in those few areas where it is required. Little stand tending is practised at present, but it may be practiced in the future as older plantations begin to require spacing (Y. Yano, pers. comm.).

Transportation corridors and access: Through a combination of logging roads and mining roads, access exists throughout much of the Quesnel Highland. The largest block of important caribou habitat without roads lies between the north and east arms of Quesnel Lake, adjacent to the northwest edge of Wells Gray Park. Bowron Lake Park and the portion of the Cariboo Forest Region that lies east of the park are also roadless.

Fire history: Several large fires that affected caribou ranges occurred in the 1960's: between Quesnel Lake and the Wasko Lakes, between Horsefly Lake and McKinley Lake, and along the entire south-facing slope of Eureka Ridge.

A 1981 fire along the east slope of Mount Tinsdale, in combination with beetle-salvage logging just west of the park boundary, may have disturbed the migration patterns of caribou moving between the Palmer Range and the early

winter habitat in the southwestern corner of Bowron Lake Park (D. Merrick, pers. comm.).

Insect attack (Vol. 2, Maps 7c, 8d): The spruce beetle and the mountain pine beetle are the most serious insect pests within Quesnel Highland caribou range. Spruce beetle attacks in Weaver Creek in the late 1960's resulted in salvage logging. Severe blowdown during storms in the late 1970's, especially unsalvaged blowdown at Indianpoint Lake in Bowron Lake Park, contributed to the current spruce beetle epidemic.

Major areas of spruce beetle attack are

- East of Bowron Lake Park - large areas
- Ghost Creek drainage - large areas
- South and east of Bowron Lake Park - many small areas
- Niagara Creek and Blue Lead Creek - a few small areas
- McKay and McKusky drainages - large areas
- Hendrix Lake area - mostly small areas

In fall 1981, regional Ministry of Forests staff calculated 15 637 ha of spruce attacked in the Quesnel Lake and Bowron PSYU's, which take in nearly all the Quesnel Highland caribou range.

Mountain pine beetle is a major problem in lodgepole pine stands in the Cariboo River drainage. The fall 1981 estimate of pine attack in the Quesnel Lake PSYU was 6 950 ha.

Both those insect pests are currently influencing forest harvesting patterns, except in areas where no access has been developed.

Other development and human activities: Prospecting and mineral exploration have been responsible for considerable access development and human activity in the Quesnel Highland. The proliferation of mining and logging roads, and especially the connection of roads to create circle routes, are concerns of Fish and Wildlife staff. Problems with snow machines and other off-road vehicles have been reported on Big Timothy Mountain, around Maeferd Lake, on Roundtop Mountain and on Yanks Peak. Regional Fish and Wildlife Branch staff proposed an off-highway closure between the North Arm of

Quesnel Lake and Cariboo Lake, which has not been approved by the Ministry of Lands, Parks and Housing.

Status of habitat in caribou ranges

A large number of winter ranges have been identified in the Quesnel Highland (Fig. 7). In some cases, we have grouped several small or fragmented areas into composite units.

Many of the low-elevation ranges in the Quesnel Highland include a rather large proportion of immature timber (2-47%), due to an active fire history as well as a long history of human activity. Although caribou are thought to use pine stands as well as cedar - hemlock stands in the Quesnel Highland, lodgepole pine did not emerge as a major component of the low-elevation winter ranges that we identified. Lodgepole pine stands in the Seller Creek area may have been masked because those small areas were grouped into a composite unit, Stevenson-low.

High-elevation ranges typically included a lower proportion of immature timber (0-22%). The boundaries of the Eureka-McCallum winter range exclude the large burn on the south face of Eureka Ridge.

According to the Mark IV data and the Landsat mapping, the only identified winter ranges currently unaffected by logging are the large Junction Supply Block (No's. 38 and 39), several small ranges between Horsefly Lake and Wells Gray Park (No's. 35, 36, and 37), and Porter Creek.

Winter ranges in Bowron Lake Park are not included in the Mark IV data base. Up-to-date inventory information for the Cottonwood PSYU was not available; the analysis for ranges 45, 46, 48, and 49 is based on a 1969 survey.

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FIGURE 7. Status of habitat in caribou ranges: Region 5-Quesnel Highland.

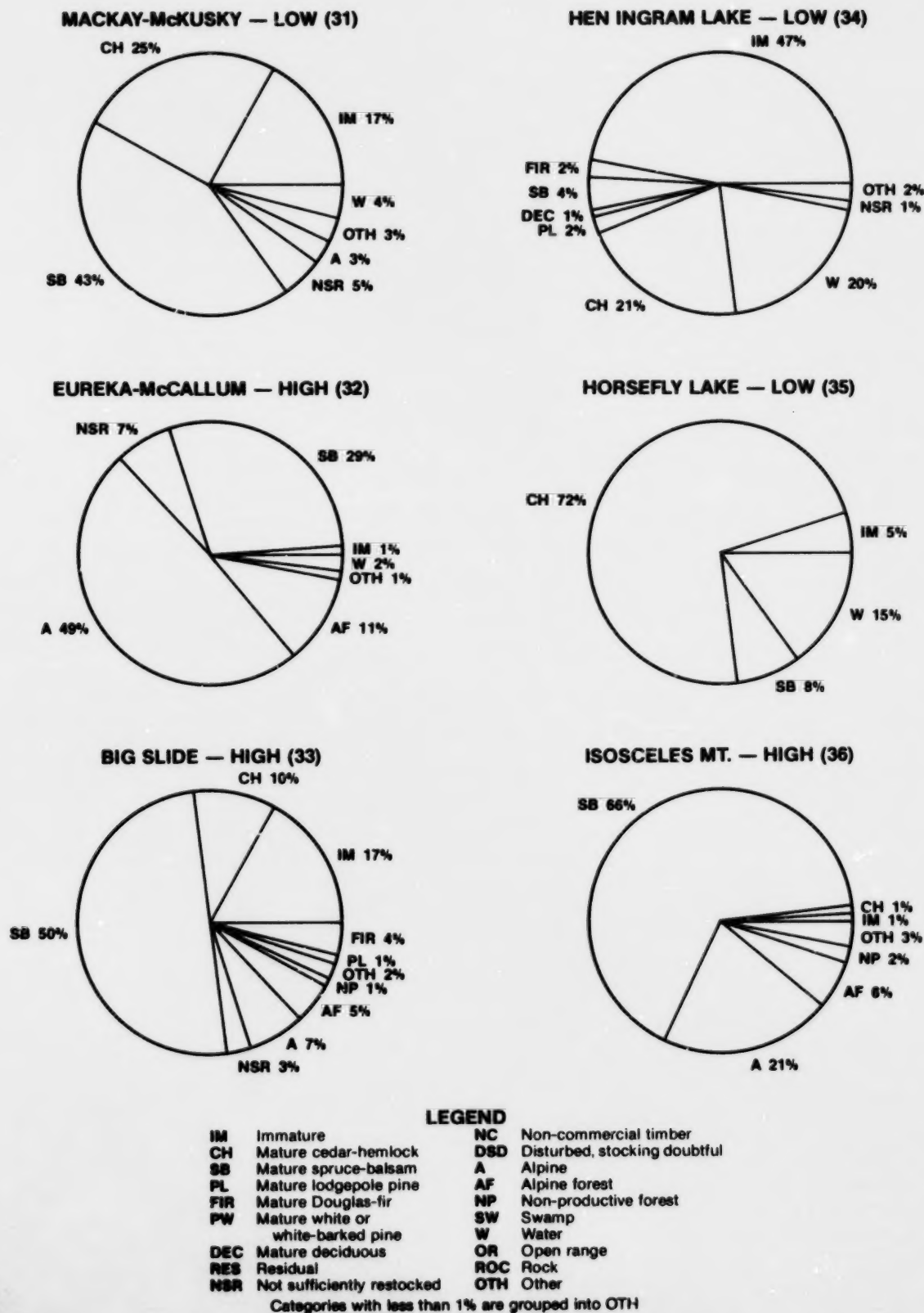
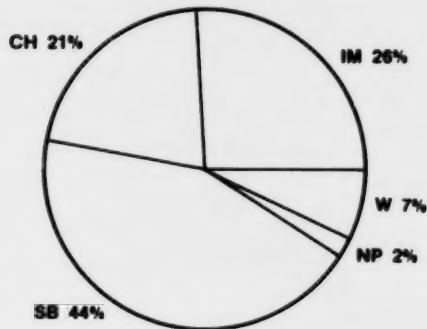
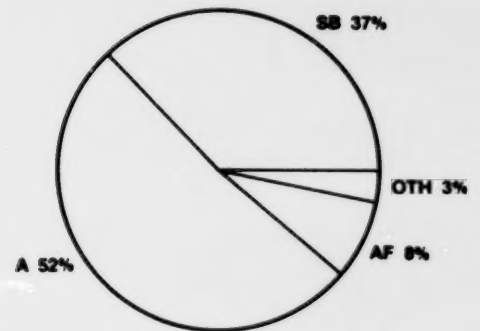


FIGURE 7. Status of habitat in caribou ranges: Region 5-Quesnel Highland (continued).

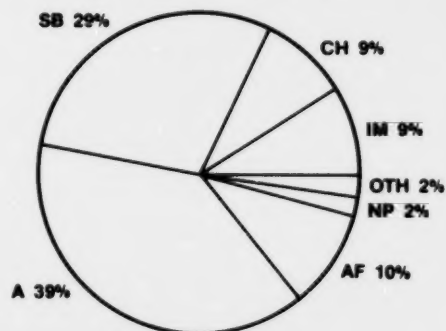
BILL MINER CR. — LOW (37)



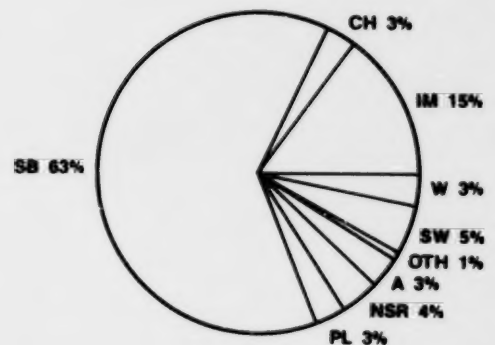
MT. MATTHEW — HIGH (40)



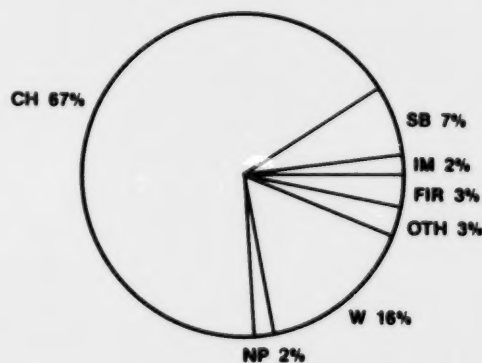
JUNCTION — HIGH (38)



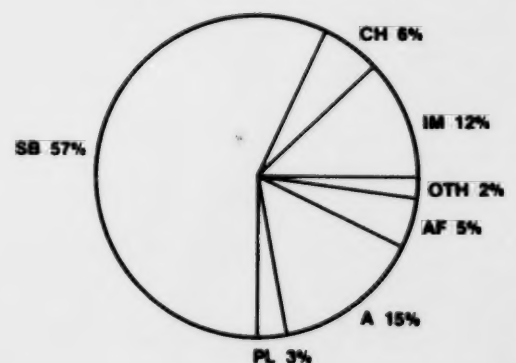
GHOST LAKE — LOW (41)



JUNCTION — LOW (39)



MT. KIMBALL — HIGH (42)

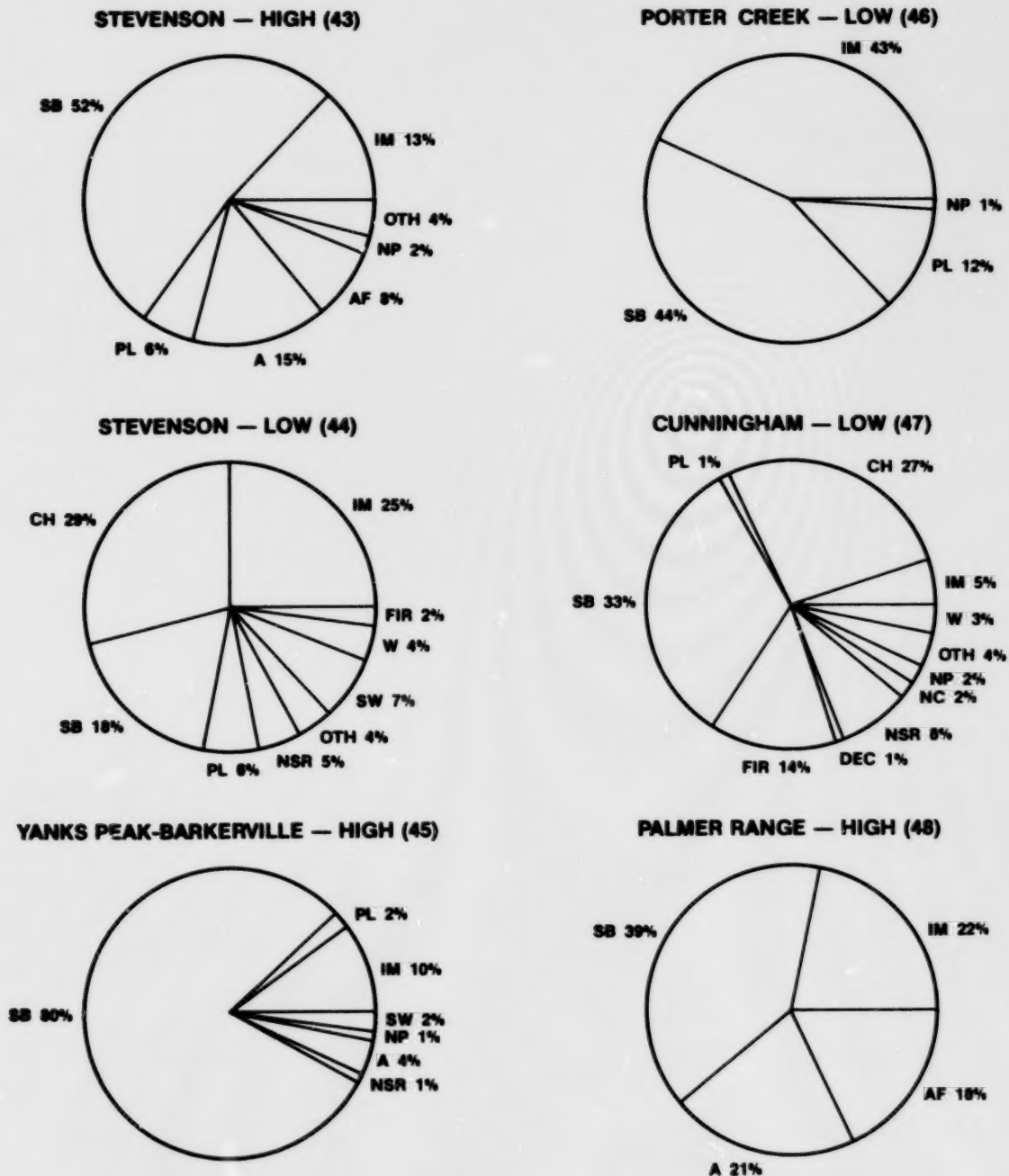


LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

**FIGURE 7. Status of habitat in caribou ranges:
Region 5-Quesnel Highland
(continued).**

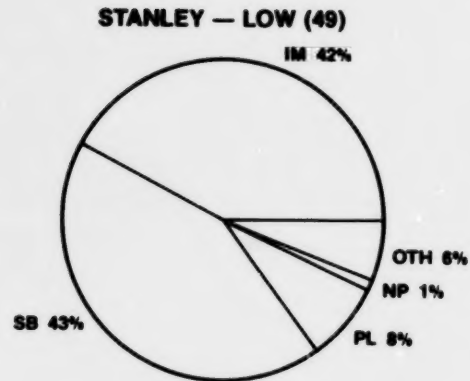


LEGEND

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**FIGURE 7. Status of habitat in caribou ranges:
Region 5-Quesnel Highland
(continued).**



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Categories with less than 1% are grouped into OTH

base. Up-to-date inventory information for the Cottonwood PSYU was not available; the analysis for ranges 45, 46, 48, and 49 is based on a 1969 survey.

Forest management planning

Quesnel Highland caribou ranges occupy the extreme eastern portions of the Williams Lake and Quesnel TSA's, and a very small area in the northeast corner of the 100 Mile House TSA.

The timber supply forecast in the Cariboo Forest Region is relatively favourable, compared to some other parts of the province (Table 1). The 20-year timber supply is adequate in all three TSA's. According to the most recent analyses the timber supply can be maintained throughout the 200-year look-ahead period (B.C. Ministry of Forests 1983). The falldown that will eventually occur will result only from the lower volume of second growth stands; no supply gap is anticipated between liquidation of old growth and maturity of the second growth (H. Giles, pers. comm.).

The Williams Lake TSA, like many others, contains large volumes of overmature timber which the Ministry of Forests wishes to see harvested before it becomes too decadent for commercial use. A severe mountain pine beetle problem in the west increases the need to remove timber rapidly (Cariboo Forest Region 1981b). A management decision to accelerate cutting, especially in mountain pine beetle areas, is reflected in the AAC. This decision may affect other forest resources by altering current cut and leave patterns (H. Giles, pers. comm.).

Although the long-term analysis (B.C. Ministry of Forests 1983) does not indicate a falldown within the next 200 years, fluctuations in the actual harvest level, due to the age and condition of stands, are anticipated. Present mature volumes of cedar and hemlock will be depleted in about 25-30 years (M. Carlson, pers. comm.). At that time the commitment to cedar mills must be deleted or converted to other species.

The AAC for the Williams Lake TSA does not include the three western supply blocks (AAC Determination, Williams Lake TSA, 7 May 1981). It does include the Junction Supply Block, which is the large, unroaded block of caribou habitat between the north and east arms of Quesnel Lake. A public involvement program regarding the proposed development of the Junction Supply

Block is currently under way.¹ The major issue is the use of Quesnel Lake for bundle-booming of logs, because developing road access to the area would be difficult. If the Junction Supply Block is not logged, the AAC for the TSA would be reduced by 7%; this could necessitate closure of a mill (H. Giles, pers. comm.).

The Quesnel TSA, like the Williams Lake TSA, has a mountain pine beetle problem, but the infestation has so far remained moderate enough that losses could be salvaged within the constraints of the AAC. If the infestation increases drastically, the AAC must be raised, possibly causing a future reduction in the harvest rate (AAC Determination, Quesnel TSA, 28 January 1981); (Cariboo Forest Region 1980; B.C. Ministry of Forests 1983).

The Bowron Unregulated Supply Block was not included in the determination of the 1981 AAC, because timber from that area probably cannot be delivered economically to Quesnel. This supply block takes in the unroaded caribou range east of Bowron Lake Park. Problems of access to the area are under study.

Insect attack and large volumes of old growth are also problems in the 100 Mile House TSA (Cariboo Forest Region 1981a). The AAC determined by the chief forester represents a compromise between rapid liquidation of old growth, and rationing of old growth to achieve an evenflow of timber (AAC Determination, 100 Mile House TSA, 11 May, 1981); (B.C. Ministry of Forests 1983).

From the standpoint of timber management, the major problems in the Quesnel Highland appear to be the overmature age structure of the forest, and the possibility of withdrawals from the forest land base for other resource uses. Insect pests are also a problem, but at present, they are not as severe a problem as in some other areas.

Habitat protection: The major thrust of habitat protection for caribou has been preservation of adequate areas of mature timber:

¹As of December 1984, a decision has been made to log in the Junction Supply Block, and road construction has begun.

1973: A moratorium on logging above 4000 ft. (1219 m) within the Quesnel Highland was proposed by Fish and Wildlife staff, and rejected by the Ministry of Forests because of timber commitments to industry.

1976: Guidelines arising from the work of Russell and Russell (Beets and Russell 1976a) were proposed by the Fish and Wildlife Branch. They emphasized restrictions on logging in low and mid-elevation timber types used by caribou as early winter range, and along movement corridors. Protection of late winter habitat was not emphasized, as logging development was not taking place at high elevations. Those guidelines were accepted by the Forest Service and industry for a 3-5 year period.

1978: EPA maps prepared by Fish and Wildlife staff included important caribou habitat. However, revisions of those maps by the Forest Service did not recognize many areas that Fish and Wildlife staff considered critical (Young and Beets 1980).

1980: Habitat Protection staff prepared a new set of guidelines designed to protect high-elevation habitat of caribou, mountain goat, and grizzly bear (Young and Beets 1980). These guidelines, which applied to portions of the Quesnel Highlands where wildlife values were high, included total protection of designated forests above 1500 m, extended rotations and small cutblocks in designated early winter ranges of caribou, and protection of migration corridors and fringes of timber around lakes and muskegs important to caribou.

The Ministry of Forests has not responded formally to those proposed guidelines, but the Planning staff have calculated the effect they would have on the AAC. The reduction in mean annual increment represents 1.8% of the AAC in the Quesnel TSA, 3.8% in the Williams Lake TSA, and 1.0% in the 100 Mile House TSA (W. Swanson, letter to W. MacGregor, 14 October, 1981). Regional Ministry of Forests staff feel that they cannot act on the proposed guidelines without a policy decision from Victoria. Accordingly, they are awaiting the ELUC decision on old-growth timber in the Quesnel-Shuswap Highlands, which is to follow the final report of the Caribou-Old Growth Working Group of the

ministries of Environment and Forests. In the meantime, decisions on logging within caribou habitat are being handled through the referral process.

2.5.3 Information needs

The only seasonal range that is fairly well known in the Quesnel Highland is late winter range. If habitat types other than slides are used in spring, they have not been identified. Calving areas and rutting areas are unknown, and habitat selection in summer is not well understood. Habitat Biologist M. Beets identified early winter range as the most important gap in information about seasonal habitat use. What characteristics do caribou select for in early winter habitat, what resources do they use on these sites, and how do they respond when early winter ranges are logged? Information on movement patterns and home range size is also required to identify priority areas for habitat protection. Most of those information needs are being addressed in an ongoing study (Appendix 3).

2.5.4 Information base (see also Appendix 3)

Aerial surveys

CLI - 1&2/69, 2/71

Fish and Wildlife - 3/11/65, 7/11/65, 2/4/71, 3/1/72, 4/10/74,
4/18/74, 2/22/78, 3/31/78, 1/25/79, 3/22/79, 5/1/80

- most were in winter

- most were not mapped

Ground survey - Fish and Wildlife, Long Creek area, 7/5-10/81

Several maps of caribou ranges prepared by H. Mitchell, M. Beets

Incidental sightings - a few

D. Russell and S. Russell caribou habitat study 1975-76

Major activities: Literature review, interviews with guides and trappers, vegetation classification, arboreal lichen survey, some observations of caribou and caribou habitat use.

Maps: Winter caribou sightings, early winter ranges, some late winter ranges.

Reports: Russell and Russell (1976a, 1976b); Beets and Russell (1976a, 1976b, 1976c, 1976d).

Maps of caribou sightings and ranges prepared by J. Ferguson, Bowron Lake Park.

2.6 Caribou Forest Region - Fish and Wildlife Region 5: Itcha, Ilgachuz, and Rainbow Mountains

2.6.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Map 14a): Caribou are found in the Rainbow Mountains, the Ilgachuz Mountains, the Itcha Mountains, and on the plateau north and east of the Itcha Mountains. One recent sighting was made about 50 km east-northeast of the Itchas. The nearest known caribou range is in the Fawnie Hills (Region 6), about 50 km to the north. Interchange with those animals is unknown, but seems probable.

Historic changes in distribution: Caribou were apparently plentiful in the Caribou Mountains (south of Highway 20 in Tweedsmuir Park) through the 1920's, but populations crashed in the 1930's (Ritcey 1956) and they are absent now. They were reported as far south as Charlotte Lake in 1955-56 (Ritcey 1956) and as far west as Firvale in 1967.

Numbers, status and management

Considering that the caribou ranging over western Region 5 apparently constitute the largest local population in the present study area, there are remarkably few pertinent observations and its history is poorly known. Presumably reference to "Chilcotin caribou" in early Reports of the Provincial Warden refer to those animals, which were considered to have been "almost exterminated" by 1916. In the following 30 years, the only other mention of caribou in that area is that in 1934 they appeared to be increasing, but with few being taken by hunters.

The first clearly specific reference is in the report for 1947, which noted that caribou had been seen in the Itcha Mountains, and that 8 had been killed there. Accounts for 1948-49 emphasized the need for surveys to explain "why caribou have dwindled down to a mere remnant of their former numbers," yet reports from guides at that time indicated the animals were still or again increasing in the Itcha Mountains. In 1953 it was stated that "The caribou

herds in the Itcha and Rainbow Mountains are not believed to contain large numbers of animals and remain at a constant level, according to the best reports." Harvests of 10 animals in the Anahim Lake area are reported for both 1954 and 1955, but there is no mention of numbers for those years. The last report in the series (1956), referred to a "strong band ... on the headwaters of the Baezaeko River system" and again quoted guides as indicating that caribou were increasing in the Alexis Creek Detachment.

The first official investigation in the area appears to be that of Ritcey (1956), in the Rainbow Mountains. He reported 68 sightings and estimated that the local population (Rainbows), numbered 100-150 animals. An attempt was also made in that year to locate animals on the "Caribou Mountain" ranges to the south. "Considerable numbers" had been reported for that area up to the late 1920's, but apparently there were none in 1956.

Bergerud (1978) has summarized most of the observations existent for following years through the mid-seventies. Those from the sixties were primarily in the Rainbow Mountains (now GMU 5-10), including a Canada Land Inventory survey which counted 172 animals there in February 1967. It is not clear why the Itchas and Ilgachuz ranges were so studiously ignored in those years. As shown in Appendix 1, Region 5 (Vol. 2), the only pertinent observations in that period were a Fish and Wildlife count of 106 animals in May 1971 and 310 animals seen by Bergerud on a fixed-wing aerial survey in early January 1973. The first intensive survey by Fish and Wildlife Branch staff in GMU 5-12 was in April 1977, when 238 animals were found there.

The relationship between animals occurring in the Rainbows and those in the Itchas and Ilgachuz is very important in consideration of population size and trend in western Region 5. Based on the presence of trails and interview information collected by Miller (1977), Bergerud (1978) felt that interchange between the two areas "probably" occurs, but he nevertheless attempted to assess herd status for the two areas separately. Mitchell (1978) doubted that there is such interchange, but did not give any reasons. He indicated that the Rainbows had been de-emphasized during Fish and Wildlife surveys in the seventies "because it is in the park". Further, T. Smith (pers. comm.) noted that animals are harder to find in the Rainbows Range, and that it is usually flown last. He stated that by the time survey crews get there they have been

flying five hours, so that if they don't find caribou right away, they usually end the survey abruptly at that point.

The result is that even though the two areas have been counted on the same survey on two occasions, the results for the Rainbows were believed to be too low. This was stated explicitly in regard to the count in May 1971, when 92 were counted on the Rainbows in comparison to 106 on the Itcha-Ilgachuz area (Mitchell 1978), and was implied for the November 1978 survey (R-37, I-I-353). In regard to counting both areas on the same survey, timing is doubtlessly important. Miller's (1977) interpretation that the Itcha-Ilgachuz area is primarily winter range and the Rainbows the summer area is clearly incorrect, since significant numbers of females and calves have been counted in the former area in summer in recent years (D. Hebert, pers. comm.). Thus, it is likely that summer surveys would produce counts for both areas, while the November surveys in the Itcha-Ilgachuz area in 1978, 1979 and 1981 may have included animals from the Rainbows.

To summarize the foregoing, it appears that caribou "disappeared" in the Chilcotin area in the first quarter of the century, but were abundant to the west, in the Rainbow and Caribou mountain ranges, at about that time. They had dwindled there in the early 1930's, at about the time when they were believed increasing in the Itchas. It seems possible that the indicated population trends, at least to that time, reflect movements and range shifts rather than population dynamics phenomena. The pattern after the mid-thirties is not clear, but it appears that increase or stability might have been the rule up to at least the mid-fifties, and caribou were known to be using both the Rainbows and the Itcha-Ilgachuz areas. The centre of abundance from then to about the 1970's is uncertain, because of observation bias, i.e. failure to observe the total area systematically and uniformly. However, it is apparent that the Itcha-Ilgachuz ranges have served in that role for at least the last decade.

On the basis of data through 1977, Bergerud (1978) postulated a late sixties peak for the Rainbows of possibly 200-300 animals, and implied similar timing for a peak in the Itcha-Ilgachuz. For the latter area he believed that "... the herd was never too large" and stated that "possibly 400 animals would have been a maximum" (Bergerud 1978:21). He then postulated declines for both areas. That for the Rainbows was not elaborated, but in the case of the

Itcha-Ilgachuz area he produced a population projection working from his 1973 count of 310 down toward the 1977 Fish and Wildlife survey result of 238. He refers to the difference between those two numbers as "an apparent decline of 23 percent." Counts in years subsequent to 1977 demonstrate the riskiness of Bergerud's assumptions and manipulations.

Intensive helicopter surveys in the Itcha-Ilgachuz ranges in November of 1978 and 1979 tallied 390 and 513 animals, respectively, representing consecutive "increases" of 64 and 32%. It should be noted that given the nature of the terrain and vegetative cover in the survey area, it is unlikely that even those figures represent total counts. In 1980, animals were observed in the Ilgachuz Range in January (180-200 unclassified), but those are clearly only partial counts. In 1981, another November survey resulted in a count of 475, a figure which might have been construed as representing a decrease since at least 60 of that number were calves. However, in 1982 the largest count to date, 711, was obtained on a 16-18 June survey in the Itcha-Ilgachuz. That figure included 197 calves.

Thus the caribou in the western sections of Region 5 emerge in a unique position in the context of this report, in that the task at hand becomes contemplation of where all the animals came from rather than what happened to them. Following paragraphs discuss aspects of natality and mortality enroute to final consideration of that question.

In general, information on population composition through the years suggests no difficulties with natality. Summer surveys have turned up high calf numbers, but failure to classify many adults has, in most cases, made it impossible to express calf percentages in relation to females, and thereby infer pregnancy or birth rates. An exception was Ritcey's (1956) work in which 17 of 20 females (85%) were accompanied by calves. Figures for more recent years are given in Table 6. As shown, calf percentages in excess of 15% appear to be the rule, regardless of season. Bergerud (1978) questioned the accuracy of composition counts in the May 1971 and April 1977 surveys, since calves at those times are almost yearlings and are difficult to distinguish.

The fall counts in Table 6, if composition results are accurate, indicate good calf survival over the first summer. The result for 1978 is nothing less than phenomenal, indicating an almost half-year post-calving calf ratio which,

TABLE 6. Population composition results for caribou surveys in GMU's 5-10 and 5-12, 1971-1982. Data for 1971-1977 from Bergerud (1978); those for remaining years from files, B.C. Fish and Wildlife Branch, Williams Lake, B.C.

Year	Summer surveys (after calving)				Other surveys			
	Date	Total seen	Males No. (%)	Calves No. (%) ^a	Date	Total seen	Males No. (%)	Calves No. (%) ^a
1971	-	-	-	-	6 May	198	?	57 (29)
1973	-	-	-	-	6 Jan.	310	?	46 (15)
1977	-	-	-	-	1 Apr.	138	?	32 (23)
	-	-	-	-	31 Oct.	140	?	22 (16)
1978	-	-	-	-	2 Nov.	390	52 (13)	128 (33-38)
1979	8 June	273	?	47 (17)	27 Nov.	513	82 (16)	10 (2-2+)
1980	9-15 June	137	1	34 (25)	-	-	-	-
1981	-	-	-	-	4 Nov.	475	58+ (12+)	62+ (13-35) ^b
1982	16-18 June	711	-	197 (28-30)	-	-	-	-

asingle percentages, and the smaller figure where a range is indicated, are based upon the total number seen, including unknown numbers of males. The larger figure in a range of percentages is obtained by subtracting known males from the total seen. In such cases, the ratio is calves ÷ adult females + unclassified adults (which would include yearlings and at least some adult males).

^bIn the 1981 fall survey, a large component (242=51%) of the animals counted was not classified, but probably contained both males and calves. The lower figure is on the basis of 62+/475 and the higher is 62+/number classified, minus bulls. The percentage of calves in the classified sample, including bulls, was 62/233 = 27%.

at 33%, is in excess of Bergerud's (1971) " r_m " (30%) for the species. The observed result could be biased high either through difficulty in distinguishing between calves and yearling in November, or through failure to obtain a representative sample. The very low calf ratio (2%) indicated for November 1979 is an artifact of an apparently different survey objective at that time. Of 513 animals observed, 82 were classified as bulls, 36 were cows, 10 were calves, and the rest (385) were unclassified.

Considering natural mortality of adults, Bergerud (1978) estimated an average figure of 8% per year based upon mathematical manipulation of his guess on recruitment rate. However, as with all caribou populations in British Columbia, there are no actual data. The only information available on mortality is that due to hunting over the past two decades. Applicable hunting regulations during that period, and previously, are as follows. The extensive caribou hunting closure from the mid-forties to the mid-fifties applied to all of Region 5. The 1956 re-opening, however, was not general in the western section of the region. Areas south of the Bella Coola Highway, in present GMU's 5-6 and 5-11, were never re-opened, and GMU 5-10 (which includes the Rainbows) remained closed until 1967. As shown in Appendix 4 (Vol. 2), seasons in GMU 5-10 were liberal through 1971, averaging more than three months in duration and applying to either sex. They were shortened to 2 months, with a males-only restriction, by 1975, and the complete closure which presently applies there was instituted in 1976. The unit containing the Itcha and Ilgachuz areas, GMU 5-12, was re-opened to hunting in 1956, but the seasons through 1960 seem almost tentative at 21-27 days (males only). Beginning in 1961, seasons began to increase in length, with at least a short, added, either sex season (1961 and 1962), or either sex for the entire caribou season (1963-1966). Seasons and associated regulations in 5-12 from 1967 through 1975 were the same as those in GMU 5-10. However, open seasons have been retained to the present in 5-12, with males only seasons of 43-44 days since 1977.

Table 7 summarizes hunter harvest over the years since 1964, when area-specific estimates became available. Hunter Sample data indicate remarkably little hunting in the area over that period, especially in the Rainbows, with the peak estimated number of resident hunters (38) in 1970 and the highest estimated resident kill (29) in 1973. However, the compulsory

TABLE 7. Harvest statistics for caribou in the "southern Tweedsmuir" area of Region 5, 1964-1981. Apparently all the effort and kill data (estimates from Hunter Sample, B.C. Fish and Wildlife Branch Victoria, B.C.) are applicable to the present GMU 5-12.

Year	Hunter Sample Results				Compulsory Inspection Results				
	No. res. hunters	Res. kill	Hunter success (%)	Percent male(N) ^a	Guided kill ^b	Res. kill	Non-res. kill	Total	Mean age(N)
1964	17	7	41	100(5)	-				
1965	7	2	29	0(1)	23				
1966	34	2	11	100(1)	41				
1967	28	11	39	75(4)	22				
1968	26	3	12	100(1)	-				
1969	25	11	44	75(4)	-				
1970	38	9	24	75(4)	69				
1971	24	6	25	-	-				
1972	26	19	73	100(6)	-				
1973	46	29	63	100(7)	-				
1974	27	2	7	100(1)	24				
1975	18	3	17	100(2)	-				
1976	7	2	29	100 ^e	-				
1977	6	0	0	-	-				
1978	5	1	20	100 ^e	-	4	5	9	2.9(8)
1979	7	5	71	100 ^e	-	13	3	16	1.6(15)
1980	21	11	52	100 ^e	-	16	4	20	3.2(17)
1981	19	16	84	100 ^e	-	23	3	26	3.5(23)

^a Reported kill, by sex, in Hunter Sample.
^b As specified in Hunter Sample; guided hunters included residents over most of the 1960's and early 1970's.
^c Assumed, since season open to males only.

inspection data for 1978-1981 show that the Hunter Sample seriously under-estimated the kill in those years. In the years before compulsory inspection, the guided kill was substantially higher than that estimated for residents, apparently peaking in 1970 at 69 animals. As with other areas in British Columbia in those years, the guided hunter included some residents and their kill cannot be added to the resident component to obtain a figure for total kill. As shown in Table 7, the component of the kill by non-residents has dwindled to 20% or less in recent years.

Bergerud (1978) attributed his perceived decline of the western Cariboo animals to a "19 percent harvest in 1973". That figure was obtained by applying an estimated hunter kill of 60 (data source unknown), to his count of 310 in that year. It now seems apparent that his population estimate at that time was low, and probably the kill estimate was high. Counts in subsequent years are sufficient argument against decline in at least the past decade. Although high potential recruitment and relatively low documented mortality indicate probable increase in the years since at least 1978, it is difficult to ascertain the trend before that. It seems likely that in 1977 there was a substantially larger number than the 238-265 postulated by Bergerud (1978). Yet, the low hunter participation and kill for the years 1974-1977 if accurate (Table 7), may indicate that there were few animals around in those years. Throughout the last few decades, population shifts to and from other locations, including the North Tweedsmuir (Region 6) area, may have been important in the rise and fall of South Tweedsmuir-Chilcotin herds.

The ages of harvested caribou in the area seem unusually low (Table 7). Despite the fact that the hunting season from 1978-1981 has been bulls only, and since 1979 with the added request that hunters select only large males, most of the 23 animals taken in 1978 and 1979 were yearlings (11) or 2-year-olds (seven). The ratio for those age classes was smaller in 1980 and 1981, but was still unexpectedly high (seven yearlings and eight 2-year-olds among 40 kills). Since bulls of that age are normally difficult to distinguish from females (Fuller and Keith 1980; D. Hatler, pers. obs.), we are led to conclude that something is wrong. Some options in that regard are 1) incorrect age determinations 2) unusual growth and development on GMU 5-12 ranges 3) unusually sophisticated hunters (with the ability and patience to distinguish bulls by features other than antlers and body size), or

4) unusually irresponsible hunters, who shoot animals indiscriminately until they come up with a male.

2.6.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Map 14a): Caribou are usually found at and above timberline. Terrestrial lichens and perhaps vascular plants are dominant forage items. The northern and western slopes of the Ilgachuz Mountains are used regularly. The Rainbow Mountains may not be used when snow is deep. The Itchas and Itcha Flats have been used in some years.

Spring: No information is available.

Calving: Calving has been reported in all three ranges. Signs of calving are regularly seen in the alpine. It is not known whether calving also occurs in other habitats.

Summer: Alpine and timberline areas of all three ranges are used during June and July, but late summer ranges are unknown. Summer foods are primarily forbs such as Caltha leptosepala (Ritcey 1956) and Pedicularis spp. (Ritcey 1956; Hazelwood 1975), and some sedges and terrestrial lichens (Ritcey 1956).

Rutting areas: Rutting occurs both above and below timberline. Below timberline on Rich Creek (Miller 1977), Itcha Flats and alpine plateaus (M. Beets, pers. comm.) are suspected rutting areas.

Fall/early winter (Vol. 2, Map 14a): Habitat in this season is variable; reported ranges include lodgepole pine/meadow habitat on Itcha Flats, other forested areas, and alpine areas. Major forage is unknown; vascular plants, terrestrial lichens, and arboreal lichens may be used.

Movement routes and special habitats: Patterns of movement among the three ranges are poorly known. Two travel corridors (Vol. 2, Map 14a) between the Rainbow and the Ilgachuz mountains have been suggested (Miller 1977; Bergerud

1978). If movement routes exist that link these animals with the northern Tweedsmuir/Fawnie Hills populations, they are unknown.

Factors affecting caribou habitat

Logging: Forest harvesting has begun in the last few years around Thunder Mountain, southeast of the Itchas. That area, which is almost entirely overmature lodgepole pine, is being logged in very large (600 ha) clearcuts, leaving large reserve blocks (M. Carlson, pers. comm.)

Silvicultural prescriptions call for no site treatment or for drag scarification, especially if winter logging is done. Natural regeneration is reliable, but overstocking is likely to be a problem. Juvenile spacing or density control, by machine, will be considered when the second growth is older (Y. Yano, pers. comm.)

Transportation corridors and access: Logging and mining development are creating access from the east. A road along the Dean River separates the Rainbow Mountains from the Ilgachuz Mountains. Bergerud (1978) considered that the most serious threat to these caribou was the possible linking of this road with the road south of the Kenney Dam. That connection has not yet occurred, but is planned.

Fire history (Vol. 2, Map 14b): Frequent wildfires are characteristic of this area, and are largely responsible for the abundance of even-aged lodgepole pine stands (Annas and Coupé 1979). A burn west of Lessard Lake, dating from the 1950's, intersects one of the possible migration routes between the Rainbow and Ilgachuz ranges. In the 1960's, a very large fire occurred north of the Ilgachuz Range, between about 1000 and 1350 m. The impact of low-elevation fires such as these on the caribou is unclear.

Insect attack (Vol. 2, Map 14c): A severe mountain pine beetle epidemic is taking place in the Anahim Lake area. By the end of summer 1981, over 110 000 ha of attack on mature and immature lodgepole pine had been detected by regional staff in the Chilko PSYU. The heaviest damage is south of a line between Anahim Lake and Chezacut. There are scattered areas of attack around Anahim Peak, on the south slopes of the Ilgachuz Mountains, and in the Thunder

Mountain area. Insect infestations in these areas have spread since Map 14 was prepared. Although the logging in the Thunder Mountain area was initiated prior to the beetle epidemic, harvesting is now being directed toward beetle-damaged timber as much as possible. Because of the large areas affected and the lack of access, unsalvaged losses due to insect attacks are occurring in the Anahim Lake area.

Other developments and human activities: Exploration east of the Itchas presents problems of increased access and human activity. Seismic lines presently extend from the east nearly to Itcha Flats, making winter ranges accessible to snowmobiles (M. Beets, pers. comm.). The Rainbow Mountains are accessible to snowmachines from Heckman Pass on Highway 20. Through an agreement between Parks Branch and a Bella Coola snowmobile club, snowmobiling is restricted to the south side of the mountains (H. Green, pers. comm.).

Status of habitat in caribou ranges

The large Itcha-Ilgachuz caribou range was analyzed as a single unit (Fig. 8). Its composition differs from that of caribou ranges in the eastern part of the region. It is composed largely of open areas (A and OR) and lodgepole pine forests; the spruce - balsam component is relatively small. No forest harvesting has taken place within the mapped caribou range.

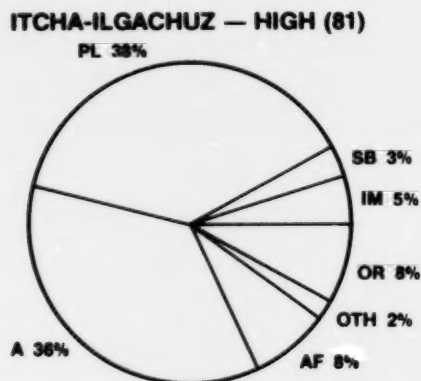
The Rainbow Range was not analyzed, as it is situated largely within Tweedsmuir Park, where inventory data are lacking.

Forest management planning

The Rainbow Mountains are in Tweedsmuir Park, and are not subject to logging. The Itchas and Ilgachuz are in the Williams Lake and Quesnel TSA's (Section 2.5).

Because of the long haul distance to Williams Lake, and the poor quality of the timber, operability of the western part of the Williams Lake TSA is marginal under current economic conditions. For those reasons, the three western supply blocks, which include most of the caribou range, have been withheld from the AAC (AAC Determination, Williams Lake TSA, 7 May 1981). However, a company is currently licensed to operate in the area. Further

**FIGURE 8. Status of habitat in caribou ranges:
Region 5-Itcha-Ilgachuz.**



LEGEND			
IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

logging is planned east of the Itchas (H. Giles, M. Carlson, pers. comm.), and more caribou habitat is likely to be affected.

The western supply block of the Quesnel TSA presently lacks major access. However, it was included in the AAC determination because operations were considered to be feasible within the next 5 years (AAC Determination, Quesnel TSA, 26 January 1981). Development in this area could affect caribou by bringing access closer to the northern slopes of the Itchas and Ilgachuz, by disturbing possible movement corridors between these ranges and the Fawnie Hills, and by altering forested habitat that may be used by caribou.

Logging on the lower slopes of the Itcha and Ilgachuz ranges themselves is not likely for some time (H. Giles, pers. comm.). In general, flexibility in meeting the timber demands in this area is high, compared to most other parts of the study area.

Habitat protection

Little habitat protection for caribou has been done in the Itchas-Ilgachuz, as the logging and mining developments are very recent. Regional Fish and Wildlife Branch staff tried to institute an off-road vehicle closure for the area, but it was not accepted by the Ministry of Lands, Parks, and Housing.

2.6.3 Information needs

The role of forests in the ecology of the caribou is poorly known, making habitat protection difficult. Little is known of the relationships among caribou in the Itcha, Ilgachuz, and Rainbow Ranges. Nothing is known of any connection between those animals and the animals in the Fawnie Hills and northern Tweedsmuir Park.

2.6.4 Information base (see also Appendix 3)

Aerial surveys

CLI - 1,2,3/67, 1/25/68

RAB - 7/20-25/79

Bergerud - 1/6/73, 9/31/77

Fish and Wildlife - 5/6/71, 12/31/71, 4/1/77, 6/1/78, 11/2/78,
5/30/79, 6/8/79, 11/27/79, 11/4/81, 3/23/82 (Region 6)

- some flights in all seasons
- most were not mapped

Ground survey - Fish and Wildlife, Ilgachuz Mountains, June 9-15, '80

Incidental sightings - very few

Reports:

Ritcey (1956) - Summary of existing information on caribou in southern Tweedsmuir Park; report on summer ground survey in Rainbow and Caribou Mountains

Hazelwood (1975) - Report on summer ground survey in Rainbow Mountains

Miller (1977) - Report on summer ground survey in Rainbow and Ilgachuz mountains; observations of guides and local residents.

2.7 Prince Rupert Forest Region - Fish and Wildlife Region 6

2.7.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Maps 15a, 16a, 17a): Present throughout Tweedsmuir Park north of the Chezko River; occasionally present west of the park in the Tochquonyalla Range and the Kimsquit drainage, and northwest of the park in the Sibola, Kasaika and Whitesail Ranges; regularly present in the Telkwa Range and southwest at least to Herd Dome. Sightings on Tableland Mountain and at the north end of Morice Lake (Hodson 1977) suggest the possibility of occasional interchange between Sibola Peak and the Telkwa Range. Caribou are also present north of the study area in Region 6, but the distribution is discontinuous; most sightings and all known regular occurrence of northern animals are more than 150 km north of Highway 16 (D. Hatler, unpubl. data).

Also present north of Tweedsmuir Park to Francois Lake and east to the Fawnie Range and the Region 7 boundary, although it is not known whether those in the Fawnies come from the west, the south, or both. Occurrence of caribou between the Fawnie Hills and the Itcha-Ilgachuz ranges in Region 5 seems

possible, but has not been documented. Caribou are present during at least some winters in the Kenney Dam area of Region 7.

Historic changes in distribution: The distribution of caribou in the study area is apparently reduced from that of the past. Shed antlers have been found in a number of areas where caribou have not been seen recently, such as the McDonnell Range north of the Telkwa River (Theberge and Oosenbrug 1977), Nadina Mountain (D. Hatler, pers. obs.), and several peaks between Herd Dome and Tahtsa Lake (Fish and Wildlife files). Early in the 20th century, caribou were said to have migrated across the Bulkley Valley, between the Telkwa Mountains and the Babine Mountains (B.C. Ministry of Environment, Fish and Wildlife Branch 1980b). Although caribou are probably not regularly present in the Babine Mountains, there have been sporadic sightings there, as well as a few unconfirmed reports from the Nass Range. Hatter (1979) listed a number of areas adjacent to Tweedsmuir Park where caribou have been seen during winter in the past, but not recently. The current status of caribou ranges north and west of Whitesail Lake is unclear; a number of older reports exist, including a CLI observation of 58 animals on Sibola Peak in 1968, but there is little information on more recent use.

Numbers, status and management

Although the caribou in the southern half of Region 6 have not been the subjects of any intensive or long-term studies, their occurrence near some of the main concentrations of human population in the region has resulted in relatively frequent contact and a sizeable accumulation of observations over the years. These data have been reviewed and re-reviewed (Hodson 1977; Theberge and Oosenbrug 1977; Bergerud 1978; Hatter 1979; B.C. Ministry of Environment, Fish and Wildlife Branch 1980b) such that the history appears to be as securely documented as it is ever likely to be. Except for some updating for years subsequent to the reports cited above, we have come up with no significant new numbers, although we do offer some new interpretations.

For the purposes of this discussion we will follow the convention of considering the caribou in this area as existing in two separate populations, the "Telkwa herd", occurring primarily in the east-central portion of GMU 6-09 and the "Northern Tweedsmuir (Tweedsmuir Circle) Herd" centered in GMU 6-02,

but with regular occurrences, especially in winter, in GMU's 6-01 and 6-04, and with minor intrusions into the western edge of 7-12 and the southern portions of 6-09. There is, however, no conclusive evidence that these two groups have indeed been completely separate, either historically or recently.

The Telkwa Herd: The inferred and recorded history of the animals that occur in the Telkwa Range is one of pre- and early settlement abundance, major decline during about the 1930's or early 1940's, increase to a "peak" (presumably lower than that pertaining pre-settlement) in the mid-1960's, major decline again in the late 1960's and early 1970's, followed by slow increase from the mid-1970's to the present. There is no record of how many caribou occupied the Telkwa-Bulkley-Babine area in the early part of the century, but second-hand tales of "old-timer" recollections ("... north-bound caribou passing by for days ...") conjure up visions of thousands. Conservation Officer L. Cox, as quoted by Theberge and Oosenbrug (1977), was speaking in terms of "a few hundred" in reference to the 1940's. Whatever the number, there is no evidence that the animals which once apparently migrated seasonally across the Bulkley Valley limited their southward movements to the Telkwa Ranges. Indeed, if many hundreds of animals were actually involved, it seems likely that ranges further south, probably including the Tweedsmuir area, were supplying at least some of the migrants.

There has been some confusion and misinterpretation of events in previous reviews, as cited earlier. The source document for all of those studies has been a short paper (Cox 1970) which was prepared as a discussion item for conservation officers, not as a detailed scientific report. Since the history of the Telkwa caribou has been used with considerable enthusiasm as a documented example of mis-management, especially by Bergerud (1978), it seems necessary to compare previous interpretations with the facts as they have emerged in this review. Bergerud (1978:27) wrote,

The herd reached a low point in the 1940's, comprising possibly only 18 animals. The apparent cause was overhunting but recruitment wasn't measured (Les Cox, unpublished report). The season was closed from 1947-1956, at which time there were more than 100 animals. The herd increased at least to 271 animals by 1965 (a maximum r of 0.11) and then declined to 40 animals by 1968.

Viewed uncritically, the sequence of events as they appear in Cox (1970) is as follows: local overhunting in the 1940's -- survey confirmed a local decline -- local season closure based on survey data -- herd increase during closure -- local season re-opening based on survey data -- overhunting in 1960's. The actual sequence, as determined from examination of past hunting regulations and recent discussions with the author of the source document (L. Cox, pers. comm.), was: general closure in 1946 -- inconclusive surveys in July 1949 and "in 1955 or 1956" -- general season re-opening in 1955 -- reduced counts after 1968 due to overhunting (and/or other sources of mortality and/or movements).

The distinction between the words "local" and "general" as they apply to hunting closures, above, is important. A local closure implies considerable local interest and awareness, and all modern interpretations of Telkwa caribou history have supposed that "the Telkwa herd" has long existed as a separate management entity in the minds of men. In fact, as documented in Appendix 4 (Vol. 2), the hunting closure of 1946 involved most of southern British Columbia, applying to that area south of the CN main line (Jasper to Prince Rupert) and north of the CP main line (Vancouver-Kamloops-Golden). The re-opening in 1955 also applied to the bulk of that large area. Hence, it is unlikely that those manipulations of hunting seasons had anything to do with counts in the Telkwa Range. The first certain recognition of Telkwa caribou in that context was the present closure, instituted in 1973.

Apparently the first official survey in the area was conducted by L. Cox in July 1949, three years after the beginning of the general closure. It was undertaken at the urging of local sportsman, at least some of whom felt that there were still "hundreds of caribou in the Telkwa Mountains" (Cox 1970). Cox saw only 18 caribou on his two-week horseback trip, and made a "very liberal guesstimate" for the Telkwa population of "not more than 100 animals". It should be noted that Cox was new to the area, having arrived in Smithers in 1948, and his 1949 count is the only datum in the recorded history to 1975 which was obtained from the ground and possibly the only one obtained in the summer. The next official count was in about 1956 (season unknown), when an aerial survey established a count of "more than 100".

The interpretation (Bergerud 1978) that the "herd" changed in numbers from "possibly only 18 animals" in the 1940's to "more than 100" in 1956 is misleading. The data as presented in Cox (1970) can be re-summarized as

follows: probably not more than 100, as determined by ground survey in 1949 -- apparently more than 100, as determined by aerial survey in 1955 or 1956. There is insufficient evidence to document a population change, or even a difference between "counts", during that period.

Cox notes that regular surveys began in 1958, usually in March or April of each year. Unfortunately, we have not been left with the census figures for the years through 1963. Results of counts for 1964-1968, together with notes on aspects of each survey as presented by Theberge and Oosenbrug (1977), are as follows:

Year	Date	Census Result	Remarks
1964	April	180	-
1965	March	271	Perfect conditions, little snow
1966	March	166	Heavy snow, bare patches
1967	April	2	Heavy snow, animals still in trees
1968	Feb.	40	-
1968	May	38	-

In previous interpretations of the above data, the apparent increase of 91 animals between 1964 and 1965 has been less believable than the apparent decrease of 105 animals between 1965 and 1966. Theberge and Oosenbrug (1977) correctly observed that the implied 50% increase was too great to have been attributable to reproductive success, and invoked "immigration" to explain it. They did not speculate upon the source of the immigrants. Bergerud (1978), apparently intent on preserving the view of the "Telkwa herd" as a closed population, argued that it was "more likely" that the difference in counts between 1964 and 1965 arose as a result of an "incomplete count" in 1964. To support his case, he pointed out that the 1967 count was clearly incomplete, therefore animals "could have been missed in 1964 also." He did not explain his confidence in the numbers for the other years.

Despite the hunting closure instituted in 1973, there is no record of any caribou counts or observations in the Telkwa Mountains for the years 1969-1974. Since 1975 it has been common practice to look for caribou in the Telkwa Range whenever it is practical to reroute a flight in that direction, and most of the counts recorded since then (Appendix 1) were obtained in that

opportunistic fashion rather than as a result of intensive, planned caribou surveys. The highest counts recorded in 1975-77 ranged from 38 to 42. Since these numbers are about the same as those obtained in 1968, it has been supposed that the population was essentially stable during the intervening decade (Bergerud 1978). However, the absence of data for the first 6 years of that period makes it impossible to confirm such a pattern.

Mortality data for the area are of little help in interpreting the sporadic count records. Assessment of calf ratios documented over the years, over 18% of late winter populations for most counts, has led to the conclusion that predation has not been an important factor (Bergerud 1978). Direct weather effects have never been documented, but past snow conditions may have at least influenced counts by inducing changes in distribution. In an intradepartmental letter, L. Cox (unpubl. document) noted that the "somewhat severe winter" of 1965-66 might have contributed to the reduced count in spring 1966. He did not specify whether he thought some mortality might have occurred, but in another communication (Cox 1970:3) he described an obvious difference in distribution during the 1966 survey: "...the losses were startling in those areas closest to ... the heliport (Smithers) while the bunches of caribou in the more remote localities showed only slight changes and in one instance a marked increase in the locality farthest from the heliport". Whether the observed difference in distribution was due to helicopter hunting, snow conditions, or both can not be determined at this time. However, the hunting season had been over for approximately four months at the time of the survey.

Most of the emphasis on past analyses of Telkwa caribou history have focussed on hunting mortality. The combination of very liberal hunting seasons from about 1962 until the local closure in 1973 (Vol. 2, Appendix 4), the increased prospector activity, the accessibility of the area to helicopter hunting and the occasional observations and continual worries of local conservation officers (see Theberge and Oosenbrug 1977), are all consistent with the thesis of overkill. It must have happened, but the nature, pattern and extent of this overkill are difficult to document with existing data. The epitaphic summaries in previous reviews seem overly dramatic: "Two surveys in 1968 were alarming, with a drop from 1966 of 126 animals (76%)." (Theberge and Oosenbrug 1977:24). "The herd crashed in a matter of four years, during

1965-68, ..." and "... the population declined by an estimated 85 percent." (Bergerud 1978:27).

Unfortunately, the only accessible harvest data for the years of interest (above) are contained in the Hunter Sample, and it is not possible to ascertain the proportion of kill records applicable to the present area of interest (The Telkwa Mountains, present GMU 6-09). During the years of highest counts, 1964-66, the harvest was increasing in GMA 20 which included, in addition to the Telkwa Range, results from northern Tweedsmuir, the north Fraser drainage, and areas in the Skeena and Omineca mountains. Following are resident kill data from 1967 through 1975, when the pertinent management unit was MA 25:

	1967	1968	1969	1970	1971	1972	1973	1974	1975
Reported kill -	8	8	14	20	15	10	6	10	13
Projected kill -	27	20	47	59	41	39	20	28	31
% Adult male -	87	100	93	85	?	82	100	100	100

The Telkwa Range component of the kill figures is larger for MA 25 than it was for GMA 20, because the only other caribou involved were those in the Upper Skeena area. That component is still unknown, however. It may have been increasing in the early part of the period as a result of the local helicopter hunting, although access effects due to the Omineca Road were also being felt in the northern half of the unit. The mean projected kill for the years prior to 1973 was 39, while that for 1973-75, which theoretically did not include Telkwa animals because of the closure in 1973, was 26. This suggests an average annual kill of about 12 animals, about one-third of the total for MA 25, attributable to the Telkwas. However, the total kill was apparently less than average in 1967 and 1968 when the greatest part of the decline is supposed to have occurred. Further, it is difficult to conceive of a 75-85% decline occurring over a period of just 2-4 years as a result of a kill oriented largely to adult males. Although adult females were legal game for seasons of up to 80 days duration during the period of interest, they comprised only 53 of 256 reported kills (20.7%) in GMA 20 during the years 1964-66 and only one of 16 (6.5%) in MA 25 in 1967 and 1968.

The purpose of the discussion in foregoing paragraphs is not to refute the claim that caribou in the Telkwa Mountains suffered from overhunting. Rather, it is to demonstrate the fragmentary and sometimes conflicting nature of the evidence associated with a group of caribou whose history is among those we thought we knew best. Is the range of counts between 1964 and 1966 a reasonable standard for our expectations? Was that relatively high level a result of temporary occupation by groups from farther south - or possibly a number that the local range could not support? How can we know for sure which of the past counts to accept and which to reject?

The Telkwa Mountains have been closed to caribou hunting for 10 years. Counts during that time have never been extensive; if there were animals on Herd Dome, the Sibola Range or any other areas in the south half of GNMU 6-09, most surveys of the "the Telkwa caribou" would not have recorded them. Counts in recent years suggest an increasing "population", but is this apparent increase a result of reproduction and survival of a closed population and/or immigration and/or simply changed distribution such that a larger proportion of the animals are in areas normally searched? The count of 51 in 1981 was the first aerial tally over 40 since 1966. The 1982 count of 71 represents a further 39% increase, for a species whose r^m is said to be 0.30 (Bergerud 1971). On 2 March 1983 a Fish and Wildlife Branch survey found 68 animals in the Telkwa Range, including 23 males, 36 females, and nine calves. Comparing those data to the most recent previous composition count (17 December 1977, 40 animals: four males, 26 females, 10 calves), we find that males have increased 475% while the female component has increased by only 38%. Since males appear to suffer higher mortality than females both as calves (T. Bergerud, pers. comm.) and as adults (Bergerud and Butler 1978), this result is not good support for the efficiency of past counts and/or the contention that the Telkwa group is a closed population.

The Tweedsmuir Circle Herd: As with the Telkwa animals, caribou in the north half of Tweedsmuir Park have been contacted frequently over at least the past three decades, but the accrued data on populations are mostly fragmentary, and were obtained only at irregular intervals. The first major attempt to draw those data together and reconstruct the history of caribou in the area was that of Bergerud (1978). Given the scattered and unspecific

nature of most of the sources, his interpretations seem unduly bold. For example, his estimate of 85 animals for the 1977 Tweedsmuir Circle population was calculated by repeated application of 1) constant (estimated) recruitment and natural mortality rates, and 2) varying (estimated) harvest rates, to 3) an initial population figure (1962) which was also estimated. His scenarios for population increase between 1958 and 1964 are based on information that is no better.

If Bergerud's manipulations are wanting in terms of accuracy, they are nevertheless valuable heuristically. One sees clearly the interaction of mortality and natality factors, and becomes acutely aware of the need to obtain a reliable population figure at least once. As will become evident, the greatest obstacle to the generation of such a figure in the Tweedsmuir area has been, and continues to be, the absence of any certain geographical definition of the population.

Hatter (1979) has provided the most intensive and thorough study of the northern Tweedsmuir caribou to date. His assignment to that area exclusively enabled him to interview more extensively and dig more deeply than had been the case in previous work there, and he was able to generate a picture that differs significantly from that of Bergerud (1978). Following are the pertinent statements from two scenarios presented by Hatter (1979:4).

Scenario I

Bergerud (1978) provides a hypothetical population trend starting with 150-200 caribou in 1958, increasing to about 500 animals in 1964 and then declining to a present low level of about 75 head.

Scenario II

A. Blackwell states caribou increased in numbers from the mid-1940's to a population high of about 1000 animals in 1955 ... The population started to decrease but did not show a noticeable drop in numbers until 1967. It then underwent a drastic decline 4-5 years ago. He estimates about 200 caribou today.

As noted by Hatter, the two scenarios agree in suggesting "low numbers" in the 1940's, increase to peak numbers, then decline to about 20% of peak numbers

after the mid-1960's. They disagree primarily in the amplitude and timing of the peak.

As has been discussed relative to other herds, there was a closed-season on caribou hunting over most of the southern half of British Columbia between the mid-1940's and the mid-1950's, and it appears evident that the animals were perceived as being in short supply at least somewhere during the early 1940's. However, there are no data to support the contention that it was true in the northern Tweedsmuir area. Indeed, there are no data at all for that time period. The earliest documented count was 300 animals, seen by guide-outfitter Blackwell on Wells Gray Peak in September 1955. That count was provided in partial support of Blackwell's estimate of the population zenith, which he felt occurred that year.

The most important difference between the two scenarios is the difference in timing of the peak, and therefore, the beginning of the decline. The largest actual numbers available to Bergerud (1978) were from the 1960's. These included a count of 321 near Fenton Lake by Conservation Officer B. Richmond in summer 1963, and a 1963-64 estimate of 500-600 by Low (1965). Bergerud's selection of 1964 or 1965 as the peak year may be based partly upon that fact, but it also appears to be related to the timing of other factors he judged important to the argument. He notes that "poison baits were placed in the park in 1956 and 1957" and alluded to "the high calf percentages in Tweedsmuir after this control in 1962-64" (Bergerud 1978:35). In addition, the first documentably heavy hunting pressure was in the mid-1960's, and Bergerud contends that overhunting caused the decline. Good recruitment in the late 1950's and early 1960's and heavy hunting mortality in the latter half of the 1960's are both consistent with, but are not evidence for, a population peak in 1964 or 1965.

If guide-outfitter A. Blackwell, who has considerable experience in the area, was correct, and 1955 was the year of highest population, then 1) the predator control documented by Bergerud (1978) was too late to have contributed to the increase and 2) the heavy hunting pressure documented by Bergerud was too late to have initiated the decline.

Two factors that must be considered in reference to a possible 1955 peak are the hunting closure from 1946-1955 and the flooding waters of Ootsa Lake following construction of the Kenney Dam. The possible effects of the closure

are obvious, and would likely have resulted in an actual increase of animals. A 1955 peak due to the flooding is possible, but it would have been a phenomenon more apparent than real. If some of the animals usually moved to the north of Ootsa Lake for the summer months, then their inability to do so in the spring might have resulted in artificially concentrating them in the mountains of north Tweedsmuir for a time. Kenney Dam was completed in 1952 and the facilities at Kemano began producing power in 1954. According to environmental researcher H. Kruisselbrink (pers. comm.), there was no water spilled from Kenney Dam between September 1952 and June 1955, i.e. the bulk of the original flooding occurred during that period.

The Alcan impoundment has also been mentioned, and must be considered, in connection with the caribou decline. Edwards (1957) documented significant effects on moose in the area including, in addition to a large loss of winter habitat, drowning of animals trapped among floating debris and thwarted seasonal migrations. The latter occurred as a result of the barrier composed of flooded standing timber and floating debris which formed a wide belt around the shore of most of the impoundment. As Hatter (1979:16) noted, the flooding "... must [also] have had some impact on the local caribou populations". Direct effects were not documented, possibly because most of the caribou crossings were farther west, where the frequency of human occurrence was, and still is, at a minimum. However, the tendency for caribou to travel in groups results in the possibility that a single incident, such as animals breaking through the ice, could claim a large number of animals in a relatively short time.

Bergerud (1978) felt that the major contribution of the reservoir was in providing hunters with "easy access to the herd". In support, he shows plots of hunter kills in the area for each of 4 years: 1962 (nine kills shown), 1966 (34), 1969 (24) and 1972 (17). Those figures show few kills along Ootsa Lake proper, but many along Eutsuk Lake, which was not flooded. Because of the shoreline barrier of flooded trees, Ootsa is still dangerous for boaters as well as for swimming animals, and it is doubtful that many hunters attempted the 100+ km boat trip to the west end of that system. Further, if easy access by water was all that hunters lacked prior to flooding it seems unlikely that it would have taken them 10-12 years to exploit it. The heavy hunting pressure of the mid-to late 1960's was mostly by float plane (Hatter

1979), not boat access, and the flooding of Ootsa Lake did not contribute substantially to hunter access.

The gradual decline of caribou for about the decade following 1955, as described by A. Blackwell (above), was attributed by him primarily to wolf predation. The possible artificial concentration of animals south of the Ootsa barrier, as postulated earlier, could have resulted in advantages for local predators, both natural and human, or possibly in leaving too little accessible range, either generally or at some critical time, for the animals remaining. Finally, perceived losses of animals might have resulted from animals attempting to cross the reservoir and failing, or possibly succeeding and being unable to return. Note that similar arguments can be made for animals, including those in the Telkwa Mountains, which found themselves north of the reservoir after flooding.

As discussed by both Bergerud (1978) and Hatter (1979), there is evidence for heavy hunting pressure on the northern Tweedsmuir caribou during the 1960's and early 1970's, and it is generally accepted that the perceived decline in numbers during that period was a direct result. The evidence, mostly anecdotal, comes from a variety of sources, including pilots, guides, and other residents who were present at the time. The fact of at least some degree of overkill seems well enough established however, as with the Telkwa animals, the combined population and harvest data available are too unspecific to provide any reliably documentable perspective on its extent or duration.

Table 8 lists the hunting data available, including projections on resident kill and hunting pressure from the Hunter Sample, and estimates and reports of resident and guide kill from Bergerud (1978). As was the case for the Telkwa animals, the primary deficiency of the Hunter Sample information is that the proportion of the effort and kill figures specifically attributable to the subject area is not known. That proportion would have been less through 1966, when the area was part of GMA 20, than in the years 1967-74 when the pertinent administrative unit was MA 22. The methods and rationale for Bergerud's resident estimates are not clear, but they appear to be based upon data from the Cache Creek Game Check. As such, they are the most location-specific data available, but they are subject to conflicting biases: 1) hunters who lived north of the check station or did not drive to their hunting location were not available for sampling (underestimate of kill); and

TABLE 8. Harvest and hunter effort data for caribou in the Tweedsmuir Circle area, 1962-1975

	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
Effort ^a												
Hunter days	397	508	689	307	143	240	239	154	237	326	157	157
%	(25.1)	(30.2)	(30.8)	(8.4)	(5.3)	(8.3)	(10.0)	(5.6)	(6.6)	(6.7)	(6.1)	(8.3)
Res. kill ^b												
A) Bergerud	35	59	80	61	35	54	50	36	47	66	43	40
B) H. Sample	139	177	228	76	56	60	74	37	51	83	16	55
%	(29.9)	(33.8)	(28.6)	(7.6)	(6.8)	(7.0)	(7.8)	(3.7)	(4.7)	(6.4)	(3.0)	(11.0)
Relationship(AB) ^c	25	33	35	80	63	90	68	102	92	80	268	72
Males (%) ^d	79	75	80	65	76	69	81	-	63	100	100	-
Guide kills ^e	(15)	(15)	(15)	15	19	26	35	21	11	21	5	7

^aEffort - total projected hunter days (residents only) in pertinent management units, from Hunter Sample; per cent figure is the local proportion of total provincial hunter days for caribou in each of the years indicated.
^bResident Kill - A.) Estimates from Bergerud (1978); B.) Projected total kill for pertinent management units, from Hunter Sample. Note: Not all is attributable to the Tweedsmuir area (see text). The per cent figure is the proportion of total projected provincial kill for the year.
^cPercent of the Hunter Sample resident kill projection constituted by the Bergerud estimate (A/B).
^dThe proportion of the reported kill (Hunter Sample) composed of males older than 1 year.
^eFrom Bergerud (1978). Figures in parentheses estimated and others from guide reports.

2) unsuccessful hunters were probably less likely to report (overestimate of hunter success).

The GMA 20 data in Table 8 (1964-1966) show an increasing trend in both hunter pressure and kill. Unfortunately the administrative boundary change between 1966 and 1967 makes interpretation between those years difficult. For the following years there is no consistent pattern for effort (hunter days), for either the Bergerud or Hunter Sample resident kill estimates, or for the relationship between the two sets of resident kill figures. The guided kill increased regularly to a peak in 1970, and then more or less declined in following years.

It should be noted that previous analyses of Tweedsmuir data have considered the reported guide kill additive to the resident estimate. This artificially inflates the total kill figure since many of the guided hunters in the time period under discussion were residents (A. Blackwell, pers. comm.). In terms of total provincial results, GMA 20 produced about one-third of both effort and kill during the years indicated, while for MA 22 (1967-74) comparable figures remained fairly consistently below 10%. The apparent peak in MA 22 resident hunting effort and estimated kill in 1973 seems inconsistent with a steady decline in the previous years, as does the fact that the peak was achieved during the first males-only season in the area since 1960. Indeed, as with the Telkwa group, the failure of the male component of the kill to decline in any regular or significant fashion over the years is inconsistent with cumulative overhunting under either-sex regulations and with the following quote from Hatter (1979:15): "B. Harrison flew out hundreds of caribou during those years when the cow season was open, most of which were cows and calves".

Caribou continued to be hunted in the north Tweedsmuir area on a males-only basis from 1973 through 1977. Estimated resident kills for 1976 and 1977 were seven and 11, respectively. The general hunting season for caribou was closed in the area (GMU's 6-01, 6-02, and 6-04) in 1978, and a limited entry season outside of the park was instituted in 1982. A quota allotment of five permits for non-residents and 25 for residents in that year apparently resulted in a kill of only three animals, all by non-residents (Compulsory Inspection results; R. Marshall, pers. comm.). The low hunting mortality and estimated recruitment of 17% or more led to Hatter's (1979:4)

conclusion that "The herd is likely now in a recovery phase". Based on observations and estimates available to him, he projected a fall (1978) population of 241 animals, and a population growth rate of 9% annually. The recent count (20 March 1982) of 368 animals in the Fawnie Range, GMU 6-01, is generally considered a confirmation of the local population growth. In comparison to Hatter's population figure, 368 represents an average 17.5% increase annually over the following three recruitment periods, nearly double that predicted but still within the capability of the species. It should be noted, however, that the Fawnie Range is closer to a southern Tweedsmuir calving area (Itcha Range, about 70 km) than to the nearest northern Tweedsmuir calving area (Quanchus Range, 75 km).

Two final points should be made regarding the late winter Fawnie Range count: 1) The count of 368 is the largest documented count for the area (Appendix 1); 2) If the count of 368 is actually additive to the 700+ counted in the Itcha range in June 1982, the total is 6% larger than the peak of 1000 animals estimated for the north Tweedsmuir area in 1955. That is, a northward movement by the Itcha animals could result in a count which would exceed the highest previous estimate for the entire Tweedsmuir area.

2.7.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Maps 15a, 16a, 17a): Use of windswept alpine slopes has been observed repeatedly in the Telkwa Range (Hodson 1977), the Quanchus Range (Low 1965; Hatter 1979), and the Fawnie Hills (Fish and Wildlife Branch files). Grasses and sedges, low shrubs, and terrestrial lichens are thought to be the major winter forage item in those habitats.

In Tweedsmuir Park and adjacent areas, lodgepole pine - lichen stands have been used by wintering caribou. In a summer field survey, Hatter (1979) noted that terrestrial lichens covered 60-80% of the ground and appeared to be used; arboreal lichen loads were variable and never appeared to be used. Other habitats where caribou have been seen during winter are sedge meadows and lakes. Marshall (1984) observed extensive use of mature pine stands associated with wet sedge meadows during late winter, and hypothesized that the animals were using arboreal lichens.

Spring: Little information is available. Hodson (1977) observed that caribou used timbered areas as low as 1400 m from late March to mid-April 1977, when crusting conditions allowed travel on top of the snowpack. Late spring movements to low-elevation lakes and pine forests have also been reported in the Telkwas (Hodson 1977). Hatter (1979) described several migration routes thought to be used by caribou moving between winter ranges and calving areas in and near Tweedsmuir Park.

Calving season: Observations of cow-calf pairs (Fish and Wildlife Branch files) and naturally shed female antlers (Theberge and Oosenbrug 1977) indicate that calving occurs on the plateau above Harkin and Dockrill creeks in the Telkwas. Observations made by G. Hazelwood (pers. comm.) suggest that Herd Dome is also a calving site. In Tweedsmuir Park, high exposed alpine ridges in the Chikamin and Quanchus ranges have been identified as calving sites (Hatter 1979). There is also some evidence that islands in Ootsa and Eutsuk lakes are used for calving (Hatter 1979).

It is likely that forested areas are also used. In an ongoing Fish and Wildlife study, 7 of 11 radio-collared cows were located in low-elevation pine/spruce stands on 7 June 1984 (Marshall 1984).

Summer: In the Telkwas, caribou have been observed in alpine habitats and on snow patches throughout the summer. The main summering area in 1976 and 1977 included the upper reaches of the Houston Tommy, Thautil, and Emerson drainages, and adjacent heights of land (Theberge and Oosenbrug 1977; Fish and Wildlife Branch files). Herd Dome and the ridges east of the Burnie Lakes have also been used during summer.

In the Tweedsmuir Park area, Hatter (1979) distinguished between areas used during the post-calving season and areas used during the fly season. Post-calving aggregations of cows and juveniles were found in the Chikamins, on Tweedsmuir Peak, on the plateau west of Wells Gray Peak, and on Eutsuk Peak. Mature bulls were thought to be in the timber during that period. In 1978, the post-calving aggregations had begun to disperse by mid-July, presumably in response to insect harassment. In the Chikamins, some caribou apparently moved southwest to the icefields of coastal mountains, and others moved east to timbered habitats. In the Quanchus Range, snowpatches were

absent by 8 August and caribou apparently left the alpine and moved into timbered habits.

Rutting season: Rutting occurs on several alpine plateaus in the Tweedsmuir Park area. There is some evidence that lowland sites, such as meadows near lakes, are also used. Hatter (1979) identified Tweedsmuir and Wells Gray Peaks as known rutting grounds. The Chikamin Range, Mount Wells, Michel Peak, and Eutsuk Peak were suspected rutting sites. Rutting was also suspected to occur along Eutsuk Lake near Sand Cabin Bay and Connelly Bay, near Fenton Lake, and between Blanchet and Nutli lakes. No rutting areas outside the park are known.

Little information is available on rutting areas in the Telkwa Range. G. Hazelwood (pers. comm.) has identified the plateau east of the Burnie Lakes as a rutting area. Observations of 15 animals in the upper Houston Tommy drainage on 30 September and 3 October 1977 may represent rutting groups.

Fall/early winter (Vol. 2, Maps 15a, 16a, 17a): Little is known of specific habitats or habitat use during this period. Many caribou apparently move out of the central area of the park along movement routes described by Hatter (1979) and Marshall (1984). Caribou wintering in the Entiako-Johnny Lake area in 1983-84 switched from immature lodgepole pine in early winter to mature lodgepole pine in late winter, apparently in response to increasing snow depth (Marshall 1984).

Movement routes and special habitats: Movement routes in the Tweedsmuir Park area are shown in Maps 15a and 16a (Vol. 2), based primarily upon information compiled by Hatter (1979) and upon current Fish and Wildlife studies (Marshall 1984). Movement routes in the Telkwas are largely unknown, although a north-south corridor along the northeast end of Morice Lake has been suggested (Hodson 1977).

Factors affecting caribou habitat

Logging: Logging within caribou ranges in the southern part of the Prince Rupert Forest Region did not begin until after the establishment of close utilization standards. Therefore, there is no backlog of old partial cuts

within areas currently used by caribou. Clearcut logging, which may have affected caribou habitat, has been done primarily in the Goathorn Creek area, in the Shelford Hills, and in the Henson Hills. Logging in or adjacent to caribou ranges has so far been limited to low-elevation sites (C. Kindt, pers. comm.).

Silviculture prescriptions are based on guidelines established through the Ecological Classification program. On most sites in caribou ranges, the policy is to broadcast-burn and plant immediately with pine or spruce. However, a backlog of untreated and unplanted cutblocks exists in some areas. A major silvicultural problem in the Lakes TSA, which includes caribou ranges east of Tweedsmuir Park, is extensive areas of young, overstocked lodgepole pine stands. Plans are being developed to space and fertilize these stands (G. Lloyd, pers. comm.).

Transportation corridors and access: Access to the core of the caribou ranges in the Tweedsmuir Park area is limited. The park itself is accessible only by lake and by trail. Northwest of Ootsa Lake, road access exists into the Shelford Hills and parts of the Sibola Range. The area north of Ootsa Lake between the Shelford Hills and the Henson Hills is extensively roaded and settled. The effects of these roads north and east of the lake are unclear; little recent caribou use of the areas has been reported.

East of the park, logging roads have been constructed in the White-eye Lake area, and harvesting is expected to begin in 1983. The 5-year development plan for this winter range calls for road construction northwest along Ootsa Lake, west as far as Chief Louis Lake, and south of the Chelaslie River (R. Apps, pers. comm.). Public use of the road system for recreation is limited by the water crossing over Intata Reach.

The Fawnie Hills are accessible by four-wheel drive mining road from the east. Snowmobiling in this winter range is unlikely, due to its distance from settlements.

Caribou ranges in the Telkwas are more readily accessible. A mining road provides four-wheel drive or snowmobile access to Hunter Basin, at the headwaters of Cabinet Creek. The plateau at the headwaters of Emerson and Houston Tommy creeks is accessible to all-terrain vehicles by way of an old mining trail. There is also a road up Howson Creek, but it is unusable

because the bridge over the Telkwa River is out. Both usable roads permit access to alpine caribou ranges, and both are regularly used by snowmobilers. This is considered a major management problem by the B.C. Ministry of Environment, Fish and Wildlife Branch (1980b).

Fire history (Vol. 2, Maps 15b, 16b, 17b): The area east of Tweedsmuir Park has a history of extensive fires which have resulted in large areas of even-aged lodgepole pine forest. Stands aged 41-60 years are especially common, due to major fires in the dry 1930's (Prince Rupert Forest Region 1981c). Since that time, numerous small fires within known caribou ranges east of the park may have had local effects on habitat use. A number of larger fires have occurred east of currently known caribou ranges. Because the past distribution of caribou in this area is poorly known, the effects of these fires cannot be evaluated.

The large areas of lodgepole pine in northern Tweedsmuir Park suggest that fire frequency has been high historically. Relatively few fires in the park are recorded in the Provincial Fire Atlas. A fire in the 1960's occurred on the north side of Eutsuk Lake, opposite John Buchan Island, in suspected late summer/fall caribou range. West of the park, few large fires have been recorded. Several fires in the Shelford Hills in the 1970's, in combination with clearcut logging, may have had significant effects on caribou range.

Few fires have been recorded in the Telkwa Range. A 1950's fire in the valley west of Corona Peak was probably outside of caribou ranges.

Insect attack (Vol. 2, Maps 15c, 16c, 17b): Spruce beetle is a serious problem in the Lakes TSA, east of Tweedsmuir Park. An infestation in the White Eye Lake area has been ongoing for several years, and is now probably declining. The epidemic has resulted in a spruce kill of up to 80% in some areas, and large volumes of timber that is no longer merchantable. A trap tree program was instituted in 1981. Harvesting is expected to begin in 1983 (R. Rowsell, R. Apps, pers. comm.).

Mountain pine beetle is not epidemic east of the park at present, but is a cause for concern because of the large volume of susceptible lodgepole pine (Prince Rupert Forest Region 1981c).

Serious infestations of mountain pine beetle and spruce beetle exist in Tweedsmuir Park. Pine beetle attacks are scattered throughout the park in susceptible stands; spruce beetle attacks extend from the north shore of Eutsuk Lake south to Sigalut Lake. Mapping carried out in 1981 by regional Ministry of Forests staff showed that 6217 ha of pine and 6571 ha of spruce in the park had been attacked. The map has been used to develop a fire protection plan. Salvage logging within the park is not contemplated (R. Rowsell, H. Green, pers. comm.).

West of the park, minor mountain pine beetle infestations are present in the Shelford Hills.

In the Telkwa Range, mountain pine beetle and spruce bark beetle infestations are scattered from Four Creek east to Coffin Lake. Salvage logging is being directed to this area, but much of the attacked timber is considered non-harvestable. Proposed cutblocks in the beetle-attacked area are so far limited to elevations of 1100 m or less.

Other developments and human activities: The Kenney Dam was completed in 1952 and subsequently caused the flooding of the Ootsa Lake system. Possible effects of the impoundment on caribou populations were discussed in Section 2.7.1. The impact, if any, from habitat loss due to the flooding is not known.

The accessibility of the Telkwa Range has led to conflicts between recreational use and protection of caribou winter range (B.C. Ministry of Environment, Fish and Wildlife Branch 1980b). Following the recommendations of a Fish and Wildlife Branch consultants' study in 1975, members of the local snowmobile association agreed informally to avoid using the Hunter Basin area. However, many snowmobilers do not belong to the association, and snowmobiles are seen regularly in the Hunter Basin area and in other Telkwa caribou ranges. The B.C. Ministry of Environment, Fish and Wildlife Branch (1980b) has documented a flight response of caribou to snowmobilers who were 1/4 - 1/2 mile away, and unaware of the presence of the animals. Hodson (1977) cited evidence suggesting that snowmobiles may have caused the fragmentation of bands which were observed among caribou in that area. The B.C. Ministry of Environment, Fish and Wildlife Branch (1980b) recommended that snowmobiles be banned from designated areas in the Telkwa Mountains between 1 November and 30 April. As of 4 March 1983, it was reported that

formal action at the political level had still not been taken on that recommendation (D. Reynolds, W. Macgregor, pers. comm.).

Status of habitat in caribou ranges

The three low-elevation ranges in the region are similar in composition (Fig. 9): they are composed largely of mature lodgepole pine (56-67%) and immature timber (17-23%), most of which is also lodgepole pine. The high-elevation range in the Fawnie Hills is composed mainly of spruce - balsam, alpine and alpine forest, but caribou ranges in the Telkwas and at Sibola Peak are mainly alpine. It is possible that caribou in the latter two areas also use lower elevation, forested ranges, but none have been identified.

Of the six ranges that were mapped, Henson-Cheslatta-Kenney has sustained logging and logging is currently underway in the White Eye range. The other ranges are unlogged, although there is forest harvesting on the lower slopes of the Telkwa Range, outside the mapped area.

Caribou ranges within Tweedsmuir Park are not included in the Mark IV data base.

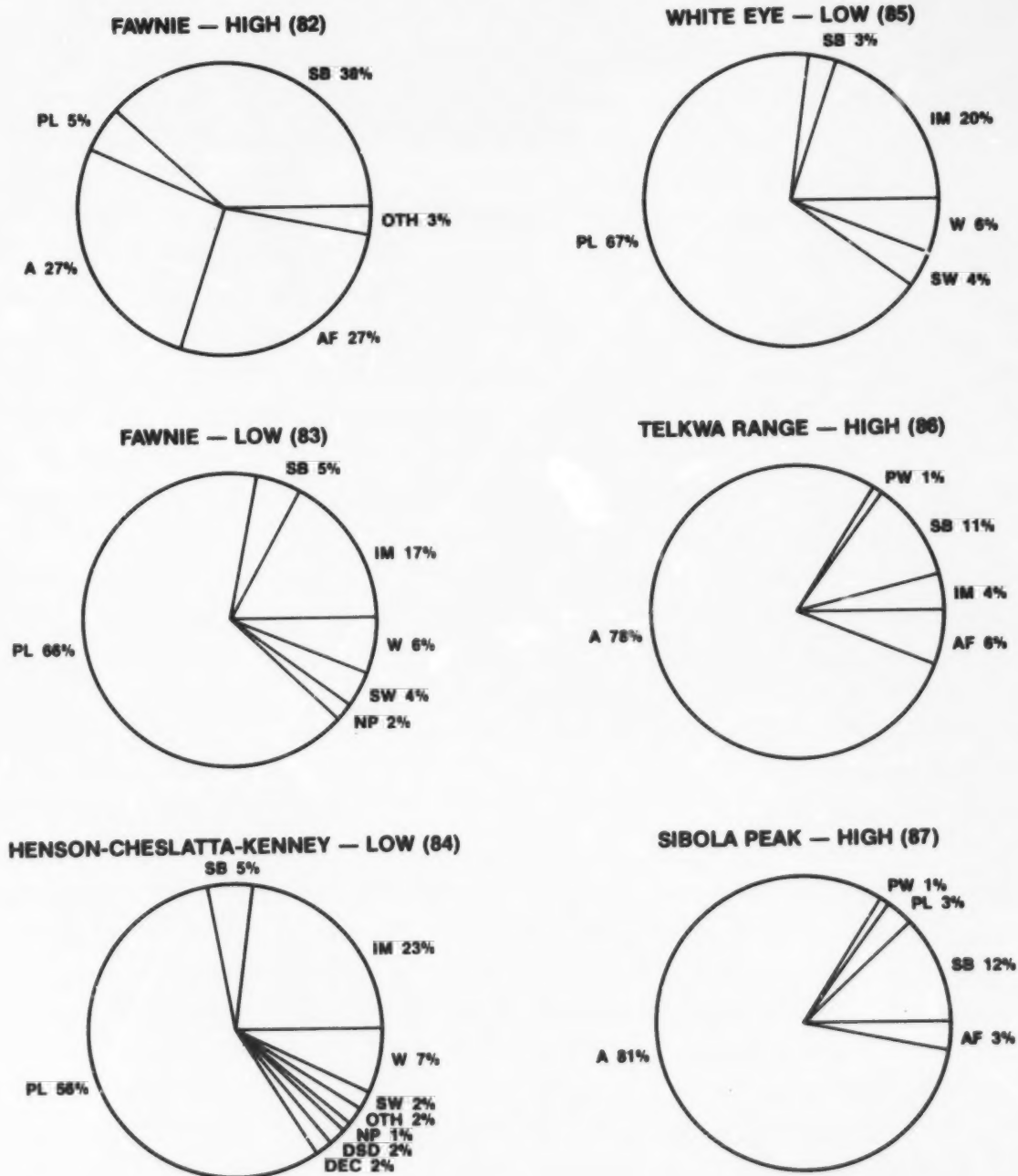
Forest management planning

The northern portion of the Telkwa Range is located in the Bulkley TSA and the southern portion in the Morice TSA. Caribou ranges west of Tweedsmuir Park and Francois Lake are in the Morice TSA. The Lakes TSA includes the area between Francois Lake and Ootsa Lake, and the area east of the park to the regional boundary.

The Lakes TSA is experiencing a serious short-term timber supply deficit (Table 1). Under present harvesting constraints, an 18-year wood supply is available (B. Siefert, pers. comm.). Extensive logging has taken place in parts of the TSA during the last 5-10 years. Because of the Ministry of Forests guidelines calling for a 20- to 30-year leave period between passes, significant volumes of second pass wood in these areas must be deferred beyond the 20-year short term. Only about one-third of the accessible coniferous volume is available after harvesting constraints are applied (Prince Rupert Forest Region 1981c).

Existing development area commitments to licensees in the northern part of the TSA limit further expansion in those areas. Therefore, demand has shifted

FIGURE 9. Status of habitat in caribou ranges: Region 6.



LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH



to uncommitted areas in the southern part of the TSA. This means that the pressure on the timber supply is especially severe in those parts of the TSA which support caribou.

The AAC established in 1981 represents a slight increase over previous commitment levels (Allowable Annual Cut Determination, Lakes Timber Supply Area, 14 October 1981). Harvesting was directed toward timber that is susceptible to mountain pine beetle attack. In the future, a reduced AAC is possible, perhaps before the usual 5-year interval has elapsed. If the AAC is not reduced, there will be considerable pressure to alter harvesting constraints by changing three-pass to two-pass harvesting prescriptions, or by significantly reducing the leave period between harvests. Such changes would aggravate the problems of meeting reforestation goals, as well as accelerating the impact of harvesting on caribou and other non-timber resources (Prince Rupert Forest Region 1981c; B. Siefert, pers. comm.).

The long-term supply analysis (B.C. Ministry of Forests 1983) indicates that falldown to nearly the Long Run Sustained Yield level will occur after 150 years.

Short-term flexibility is considerably greater in the Morice and Bulkley TSA's than in the Lakes TSA (B. Siefert, pers. comm.). In the Morice TSA, the short-term timber supply is adequate (Prince Rupert Forest Region 1981b). However, problems are anticipated in the long term; a falldown of 33% is indicated after approximately 80 years (B.C. Ministry of Forests 1983). The 1981 AAC was increased slightly to give high priority to harvesting insect-infested lodgepole pine and spruce stands, and old-growth balsam. (Allowable Annual Cut Determination, Morice Timber Supply Area, 16 June 1981).

In the Bulkley TSA, the short-term timber supply is adequate, and the long-term analysis is more favourable. Current demand is within 5% of the Long Run Sustained Yield (B.C. Ministry of Forests 1983). Shortfalls below the Long Run Sustained Yield level are anticipated after 100 years, but opportunities exist for increasing the yield by using pulp stands (Prince Rupert Forest Region 1981a). The 1981 AAC determination raised the AAC in order to minimize losses due to insects, decay and blowdown (Allowable Annual Cut Determination, Bulkley Timber Supply Area, 17 June 1981).

Habitat Protection

When logging in the Shelford Hills and the Henson Hills was initiated in the early 1970's, habitat protection measures included deletion of selected cutblocks and restrictions on cutblock size. A bubble system to maintain open water for booming in Intata Reach was recognized as a possible hazard to caribou moving between the White Eye Lake area and the Henson Hills. A fencing system was recommended and carried out (Fish and Wildlife files).

In the White Eye Lake area, a system of resource corridors was established as input to the original development plan. Those corridors, approximately 750 m wide, were designed to protect suspected movement routes and lowland sedge meadows where cratering had been observed. Since the original development plan was drawn up, spruce bark beetle infestations in the area have spread, and corridors have been relocated to avoid beetle-kill areas (A. Eadie, pers. comm.).

In the Telkwa Range, logging is going on at 1100 m and below in Goathorn and Tenas creeks. Since use of these low-elevation forests by caribou is uncertain, no habitat protection recommendations have been made (A. Eadie, pers. comm.).

2.7.3 Information needs

The significance of forests to caribou is poorly known. Nothing is known of use of low-elevation habitat in the Telkwas, except that sometimes the animals cannot be found in the alpine. In the Tweedsmuir area, caribou sometimes winter in low-elevation forests, but it is not clear which forest resources (e.g., cover, vascular forage, terrestrial lichens, arboreal lichens) are important to the animals. There is some evidence that Tweedsmuir caribou use low-elevation forests during fly season, but the basis for habitat selection is not known. The effects of beetle kill on use of forests by caribou is unknown. The absence of an information base for habitat protection strategies is a serious problem.

The relationships among caribou in the Telkwa Range, in and around Tweedsmuir Park, in the Fawnie Hills, and in the Itchas, Ilgachuz, and Rainbow Mountains to the south, are unknown. There is a particular need for more information about the movements and seasonal ranges of animals that use Tweedsmuir Park during part of the year.

2.7.4 Information base (see also Appendix 3)

Aerial surveys

CLI, RAB, TSB

93E: 1&2/68, 2&3/74

93F: 1&2/66, 1/25/68, 2/7-9/74

93L: 1&2/68, 2&3/74, 2/22/82

Fish and Wildlife and/or Parks Branch flights

1/2/75, 2/11/75, 4/2/75, 1/15/76, 1/19/76, 8/5/76, 9/8/76,
3/17/77, 10/15/77, 12/19/77, 1/27/78, 2/24/78, 4/14/78, 4/24/78,
5/5/78, 7/1/4/78, 10/26/78, 1/5/79, 1/10/79, 1/15/79, 4/21/79,
10/9/79, 1/18/80, 3/31/80, 1/16/81, 11/25/81, 3/20/82, 3/23/82.

K. Hodson study (Fish and Wildlife)

The Telkwa Range was flown for caribou at intervals of
approximately 2 weeks from Jan. to Nov. 1977.

Incidental sightings

About 100. Mostly compiled by Hatter (1979).

Parks Branch reports

Osmond-Jones et al. (1975) - Report on summer ground survey of Burnie
Lakes and alpine ridge system east of lakes.

Hazelwood (1975) - Report on summer ground survey of Chikamin
Mountains and the Tweedsmuir Peak - Mount Wells areas.

Miller (1977) - Report on summer ground survey of Glattheli Lake -
Fenton Lake area and Chikamin Mountains.

Hatter (1979)

Objectives: Identify seasonal movements of caribou within and
adjacent to northern Tweedsmuir Park, determine current
population status.

Major activities: Summer and fall ground surveys, extensive
interviewing and compilation of existing information.

Maps: Wintering areas and fall migration routes, caribou
sightings

Fish and Wildlife reports

Cox 1970 - Brief history of caribou status and management in the Telkwa Range.

Hodson (1977)

Objectives: Obtain information on seasonal range requirements migration patterns, sex-age distribution, and recruitment statistics for caribou in the Telkwa Range.

Major activities: Aerial surveys, radiotelemetry (one caribou), ground surveys.

B.C. Ministry of Environment, Fish and Wildlife Branch (1980b) - Report on snowmobile conflict with caribou in the Telkwa Range.

Miscellaneous reports

Low (1964) - Report on summer and fall field studies of caribou in northern Tweedsmuir Park.

Low (1965) - Report on winter field studies of caribou in northern Tweedsmuir Park. Little contact was made with the animals.

Low (1976) - Report on parasites of caribou in northern Tweedsmuir Park. Little contact was made with the animals.

Theberge and Oosenbrug (1977)

Objectives: To assess portions of the Telkwa Mountains for merits and drawbacks in designating an Ecological Reserve, primarily for the protection of caribou.

Major activities: summer ground surveys, habitat mapping, land use review.

2.8 Prince George Forest Region - Fish and Wildlife Region 7: Omineca Subregion¹

2.8.1 Caribou populations

Distribution

¹ Only parts of the Prince George Forest Region lying west of the Rocky Mountain divide are discussed here. The portion of the Forest Region lying east of the Rockies is treated in Section 2.9.

Broad distribution (Fig. 1; Vol. 2, Maps 6a, 8a, 8b, 9a, 9b, 11a, 12a, 13a, 15a): Caribou are scattered throughout the Omineca subregion east of Highway 97. They are present in the northern part of the subregion, outside the study area. They are also present in the Kenney Dam area in the extreme western portion of the subregion. Since those animals are part of the northern Tweedsmuir herd, they are discussed in section 2.7.

Historic changes in distribution: Caribou were formerly present west of Highway 97, and a continuous population may have existed between the north Tweedsmuir area and the caribou ranges east of Prince George. Caribou are reported to have formerly crossed the Fraser River at the present site of the Highway 97 bridge, and to have wintered on Cranbrook Hill, just west of Prince George. A single animal was observed in the northern suburbs of Prince George as recently as 1962, and caribou were formerly known from west of Summit Lake (Fish and Wildlife files). Caribou and caribou tracks were observed on the Nechako Plateau, about midway between the Fraser River and the Kenney Dam, during CLI flights in 1967; they have not been reported from that area since. It is not known whether more recent sightings near Stoner and Woodpecker were associated with movements across the Fraser River.

Bloomfield (1979:145-171) compared historic and contemporary sightings of caribou east of Prince George. Although some local changes in distribution were noted, the overall pattern was one of declines in numbers of animals using the ranges, rather than abandonment of ranges.

Numbers, status and management

Although there have been numerous caribou observations scattered over almost the whole area of present interest in the Omineca subregion, most are incidental and are of little use in ascertaining population status and trend. That is, as with many of the other areas discussed in this report, multiple counts from different locations have rarely been made over a short enough time period to be clearly additive¹. It is believed that caribou in the area

¹ A notable exception is a recent survey (March 1984) in the Cariboo Mountains.

have declined in the past 15-20 years, especially locally (Bloomfield 1979) but probably also generally (Bergerud 1978, Child 1978a). Following paragraphs discuss relevant information and speculation by GMU and/or by larger units specified by the authors cited above.

1. GMU 7-1 (Mount Robson Provincial Park)

There are few records of caribou occurrence. Apparently the largest group seen in the park was 20+ seen by a Jasper park warden in the Tonquin Valley in summer 1974. General wildlife flights conducted by provincial staff produced sightings of 10 in the winter of 1969 and six in July 1974, but no animals were seen on winter flights in 1976 or 1979, and apparently there have been no incidental sightings since 1975 (M. Sather, pers. comm.). Whatever number might be considered to apply to the park, it is almost certain that they are shared with Jasper National Park to the east, GMU 7-2 to the west, and possibly even the northern extremities of Regions 3 and 4.

2. GMU 7-2 (Valemount)

There have been relatively few sightings, a fact which may be due more to lack of observers rather than to lack of animals, especially in the rugged and less accessible southern half. Most sightings in recent years have been east of Canoe Reach, and have involved only small groups. The largest was a group of seven seen in February 1977. As indicated in the preceding paragraph, it is likely that GMU 7-2 animals, at least those east of Canoe Reach, have affinities with ranges to the north, including Mount Robson Park and possibly Jasper. The single sighting west of Canoe Reach was of a group of 25 in a logging slash in fall 1980. Animals in that area probably occur at least occasionally in Region 3 and possibly in Region 4.

3. GMU 7-3 (East Twin)

As with the adjacent Mount Robson Park area, sightings in the southern/eastern half in recent years have mostly been of an incidental nature, involving small groups (maximum = eight on 15 February 1982). There appears to have been a historic centre of occurrence in the mountains north of McBride, especially in the Mount Rider-Fleet Creek area, from which there were several reports of 15-25 animals in the 1950's and 1960's. Only tracks have

been reported from those areas in the past 15-20 years, but it is not clear whether that represents a diminution of animals or of observer effort. The majority of recent sightings have come from the Morkill River drainage, many during radio-tracking flights for animals originally captured in Alberta. Also, a hunter who spent three weeks on horseback along the British Columbia-Alberta border in September 1982 reported several observations from that area. It is not clear which of his counts are additive and which may represent duplications, but one of the sightings was a group of "50-75" (No. 394 in Vol. 2, Appendix 1, Region 7). Judging from the radio-tracking work, many (if not all) of the animals seen there at that time probably use winter ranges in Alberta.

The northern half of GMU 7-3 corresponds roughly with "caribou distribution unit e" of Bloomfield (1979). He reviewed all sightings through 1977, and concluded that there had been a significant decline. He wrote that "... most recent sightings have not exceeded 4-6 caribou, and not more than 35-45 ... likely remain in the area." (Bloomfield 1979:163). As indicated above, the radio-tracking studies since his review have turned up larger groups and have demonstrated the mobility of the animals, showing that at least some of the animals in the area use ranges in GMU's 7-3, 7-18 and probably 7-19, as well as in Alberta. Overall, a fairly large population (100+?) is suggested for that general area and the remainder of 7-3.

4. GMU 7-4 (Raush)

We have only two observations for this large, remote unit, five animals southwest of Tete Jaune in March 1975 and eight in the Dore River area in summer 1981. The southern boundary fronts on the mountains at the head of the Clearwater River (Wells Gray Park, Region 3) and along the more pristine and least known "inventory blocks" (Young and Beets 1980) of the Quesnel Highlands in Region 5. Estimated occurrence in those portions of the other two regions suggests numbers in excess of 35 may occasionally frequent ranges in 7-4, but we have no certain evidence for that.

5. GMU's 7-5A, 7-5B, 7-6 and 7-7

These units, in the Cariboo Mountains, comprise the bulk of Bloomfield's (1979) study area south of the Fraser River. Both historical and recent

observations indicate an essentially continuous distribution of caribou over that area, suggesting a single population in at least the genetic sense. However, for discussion purposes, Bloomfield subdivided the area into four "somewhat arbitrary but natural geographic units." The meaning of the term "natural" in the previous sentence is not clear, but it apparently relates to topography, not caribou biology. Following paragraphs constitute an attempt to integrate population information from Bloomfield's discussion units with more recent sightings, in reference to the official administrative units for the area:

- i. GMU 7-5A (West Twin/most of units b, c and d in Bloomfield, 1979) - This long (120 km), narrow unit is best known along its northern boundary, the Fraser River, where it is traversed for its full length by the Yellowhead Highway and its tributary access roads. Caribou have been known to cross the highway at several locations along that length, and were reported swimming the river in early years, thus isolation from animals seen in ranges to the north (GMU's 7-3 and 7-17) is not likely. The height-of-land boundary to the south is certainly no barrier to movements in that direction. Bloomfield's subdivisions essentially separate the three primary foci of observations in GMU 7-5A, namely Raven Lake-Slim-Tumuch (b), Dome-Ptarmigan Creek (c), and West Twin-Legrand (d). It is possible that the focal aspect of those areas reflects the distribution of potential human observers at least as much as it does the distribution of caribou.

Bloomfield's (1979) review of available data through 1977 included several references to "large bands", especially in the 1930's when caribou were said to be declining in many other areas of southern British Columbia. There are few specific counts from the early years. Groups of 20 or more were reported for all three of Bloomfield's units as recently as the 1960's, but his appendix of historic sightings includes no references to such numbers in any two of those units in the same season and year.

During Bloomfield's (1979) study, the largest number of animals which could be accounted for in GMU 7-5A at any one time (i.e. the minimum population) was 22, all seen at Raven Lake (sub-unit b) in

winter 1975. The largest since then was 19 in the period 14-20 April 1981, including four in the Raven Lake area (b), two near Crescent Spur (c), ten at West Twin (d) and three at Legrand (d).

- ii. GMU 7-5B - This unit is too small to contain caribou except on a temporary basis. The only pertinent data include three sightings (one, two and seven animals, possibly with duplication) on Caribou Mountain over a 4-day period in September 1981. The animals involved could have come from any of the units adjacent including 7-6 (upper Haggan Creek), 7-5A (Upper Goat Creek), or 5-16 (Bowron Lake Park).
- iii. GMU 7-6 (Haggan Creek, including parts of Bloomfield's sub-units a and b) - There are relatively few sightings, and most are from the western half where, when plotted on the map, they appear as a southern extension of a continuous distribution of caribou along the mountains east of the Bowron River, i.e. including parts of GMU's 7-5A and 7-7. As many as 10 animals have been accounted for in the unit on two occasions, once on 10 October 1975 near the southwest corner (Willow River area) and again in fall 1981 near Clear Mountain in the southeast corner. Both observations were too isolated in time to be certainly additive to any counts in adjacent units.
- iv. GMU 7-7 (Narrow Lake) - Strictly speaking, observations in the Sugarbowl Mountain area are within this unit, although the height-of-land boundary there clearly cuts across alpine ranges used by animals seen also in the Raven Lake-Slim-Tumuch area (GMU 7-5A). Bloomfield's (1979) boundaries reflect that fact, including both areas in his sub-unit b. The sum of animals counted at both Sugarbowl and the Raven Lake area at one time has never exceeded or even equalled the largest number recorded at only one of those two areas in the same year. That is, it appears that the caribou are either concentrated in one place or the other, or are dispersed over the general area. The largest number attributable to GMU 7-7 at one time in recent years was a group of about 20 reported from the Tsus Lake area (west of the Bowron River) on 5 December 1976. The affinities of that group for other known caribou ranges in the area can not be ascertained, but the animals involved were probably

different from 19 recorded in the southern portion of 7-5A about one week later (12 at West Twin and 7 at Legrand).

Bloomfield's (1979) estimates for "populations" within his sub-units are categorized as "minimum, maximum and probable." The minimum estimates represent the largest numbers accounted for in each of the units at any one time in the period 1975-1978. As such, those figures constitute the basic facts on numbers in the area. The sum of his minimum estimates for the four sub-units discussed here (5+22+8+15 for a-d, respectively) is 50 animals. However, not all 50 were reported at the same time. The largest documented simultaneous total for GMU's 7-5A through 7-7 in the past decade is that referred to in the account for 7-7, i.e. the implied total of about 39 animals recorded in southern 7-5A and 7-7 in December 1976. The next largest short-term total for the entire area is the 22 animals seen together at Raven Lake in February 1975.

Bloomfield (1979) did not explain how his "maximum" and "probable" population estimates were obtained, but both are clearly speculative and were probably based upon accumulated sightings for the various areas, coupled with assumptions relating to animal mobility as it affects potential for duplication. Whatever the basis, his estimated "maximum" for sub-units a-d is 155-215, and his estimate for "probable" population in the area is 95-125. As we have shown above, the largest documentable figure for any recent short time period is 39. Since animals have regularly occurred in all four GMU's during the season involved (winter), and since counts in only two relatively small local areas produced that figure, it is not difficult to believe that a larger number (perhaps a substantially larger number) was extant at that time. However, given the spread in time between pertinent observations over the whole area, the lack of marked animals to provide any basis for assumptions on attachment to place, and the known mobility of caribou elsewhere, the jump from documented minimum to estimated population is speculative at best. In that regard, Bloomfield's estimates are as good as any.

6. GMU's 7-8 and 7-9 (George Mountain)

Bloomfield (1979) discussed occurrence of caribou between Prince George and the Bowron River in the account for his sub-unit a, which included a small

portion of GMU 7-8. His sources indicated that "groups surpassing 75-100 animals once were common" in the area, but specific documentation for sightings of such groups is lacking. The relatively few sightings for the area in recent years led Bloomfield to conclude that it might now be "at the fringe of current distributions." Nevertheless, the largest group of caribou seen south of the Fraser River in the past decade was there (about 35 seen in October 1975 along the Willow Road east of George Mountain). Other sightings in recent years have been mostly in winter, involving only small numbers of animals. Such sightings also appear to be less frequent than in the past, and in this case it is not likely a result of observer bias since human activity in the area is not known to have diminished significantly. Indeed, the general "feeling" for population decrease may be more supportable for this area than for any of the others in Region 7 south of the Fraser because of the long history and continued occurrence of human population there. Assuming that the area has always been used primarily in winter, it is possible that whatever happened there also affected animals on seasonal ranges farther east. Although Bloomfield (1979) projected a "probable" population estimate of 10-15 animals for his sub-unit a, a considerably smaller area than that over which caribou observations are known in GMU's 7-8 and 7-9, we see little basis for assigning any number to the area in the sense of regular or exclusive residence there.

7. GMU 7-16 (Captain)

There have been relatively few observations of animals in this large unit. Observations from Mount Averil and points just north of the Fraser River probably represent excursions of animals from the east, while those north of the McGregor Plateau may represent movements of animals which occur more regularly in the Rockies (GMU 7-23). The southern/eastern section of the unit, in the Otter Lake-Captain Creek area was surveyed intensively on several flights by a consultant between December 1976 and May 1977, and tracks were recorded at many locations. However, the only animals seen in that area in the past decade were three in May 1979 and four in March 1981. Overall, it appears that occurrence in the Captain Creek area may be fairly regular, perhaps mostly in winter, while that in the rest of the unit may be seasonal

and/or sporadic, with animals appearing there from centers of more regular occurrence elsewhere.

8. GMU 7-17 (Bearpaw, Severeid)

There have been many observations in this unit, which includes Bloomfield's (1979) sub-units f, h and i. The status of f (the Walker Creek sub-unit in the eastern portion of GMU 7-17) has not changed since his study. That is, there have been no additional reports either of historic or recent sightings, although tracks were observed on two occasions in January 1978 (No.'s. 278 and 279 in Vol. 2, Appendix 1, Region 7). The only documented historic record is a sighting of "35-50" near Walker Creek in summer 1944, and the only recent record involving an actual sighting of animals was of seven in February 1975. Bloomfield notes that the area is remote and "unsettled", thus it is possible that the relative paucity of sightings is due primarily to lack of observers rather than lack of caribou. If caribou do regularly occur in that area, they nevertheless probably occur seasonally in adjacent units 7-3 and 7-18.

Bloomfield's sub-unit h, north of the Torpy River, has produced several sightings, including the largest single group recorded in 7-17 (45 animals in 1948). The largest totals accounted for in the unit in both 1975 and 1976, 25 and 20, respectively (Appendix 1) were also seen there. However, most sightings since then have been of smaller groups. The largest group seen since Bloomfield's study was seven in May 1982.

Most of the significant sightings in 7-17 in recent years have come from Bloomfield's sub-unit i, south of the Torpy River. The totals (listed in Appendix 1) for the years 1977-1982 were all recorded there. Subjective recollections constituting the history of caribou in sub-unit i, as presented by Bloomfield (1979), suggest numbers in excess of 100 in the early part of the century and possibly on through the 1960's. Bloomfield's attempts to find caribou there mostly failed and there were few incidental records during his study. Accordingly, his minimum population estimate for the area was just 15, with a "probable" estimate of 20-25. In January 1982, about 2 weeks after 17 animals were killed by trains and snowplows along the CN line east of McGregor, 24 live animals were counted on Bearpaw Ridge. Whether all 41

animals had regularly or temporarily occurred south of the Torpy up to that time is not known.

The sum of Bloomfield's "probable" estimates for the three sub-units in 7-17 is 85-100. The minimum total estimate, based on the largest number actually seen in each is $7(\underline{f}) + 12(\underline{h}) + 15(\underline{i}) = 34$. As with most of the GMU's discussed previously, these figures are not strictly additive since they were not obtained at the same time. Indeed, assuming no observer bias, the data in hand suggest that the area north of the Torpy is used considerably less in winter than is that to the south, therefore winter total in i could include animals counted at other seasons in h. A current total population in excess of 35 is likely and one greatly in excess of that figure (100+) is possible. More extensive and systematic observations are required.

9. GMU 7-18 (Herrick)

Most of the observations for this large unit are from the southern half, in the Dezaiko Range between the McGregor River and Herrick Creek. There is almost certainly an element of observer bias involved, i.e., the area north of Herrick Creek has probably been observed less frequently and/or intensively than has that to the south. Bloomfield's (1979) sub-unit g included a portion of the Dezaiko Range. In discussing caribou occurrence in the general area, he noted that the largest group reported was one of 30-40 animals north of Herrick Creek in the Fontoniko drainage in spring 1940. In recent years, the bulk of the observations from GMU 7-18 were in 1977, including a September sighting of 23 animals at Hedrick Lake. That year was also the first to provide sightings in the Jarvis Creek area, near the eastern boundary of 7-18. In mid-July of that year, 10 animals were seen there at about the same time that eight were recorded in the Dezaiko Range. While there is a possibility of a continuous distribution and/or movements between those two areas, it seems more likely that the Jarvis animals are from a centre of occurrence to the east. Bloomfield (1979) projected a probable estimate for sub-unit g of 25-30 animals. Considering the size and nature of the remaining portions of GMU 7-18, it can be expected that considerably more than that would be found within its boundaries at least occasionally.

10. GMU 7-23 (Parsnip)

The most significant set of observations from this area was a flight on March 1982, on which a minimum of 38 animals were tallied in eight groups (two to nine animals per group) on uplands between the Anzac and Hominka Rivers. The only other observations from the entire northern two-thirds of the management unit have been in the vicinity of MacKenzie, where some large groups have been seen in winter (about 30 on 8 January 1975 and 27 on 11 February 1978). The latter group almost certainly involved animals distinct from 10+ seen about 100 km southeast, in the upper Hominka drainage, on 19 January 1978. Although the distribution of observations suggests three centres of occurrence (MacKenzie, Anzac-Hominka, upper Parsnip), observer bias is likely. We expect that the distribution of animals is actually continuous over the whole GMU, and with animals regularly crossing boundaries to and from adjacent units (7-16, 18, 21, 22 and 30).

To summarize the foregoing accounts on caribou populations in the Omineca subregion of Region 7, the animals have been seen at many different locations there, but, at least in recent years, rarely in groups larger than 10. For most management units there are too few observations to ascertain whether numbers in hand are applicable to those areas in terms of year-round residence, regular seasonal occurrence or just sporadic appearances. In general, those GMU's south of the Fraser River may have the most tenuous caribou occurrence. Lack of detailed baseline information makes it difficult to document any certain trend there, but the recent decline suspected by observers cited earlier seems likely. The valley from Valemount to Prince George, with its transportation corridors and increasing settlement, must now be a greater barrier than it once was, and the primary affinities of the animals south of the river must now (if not in the past) be either to the south (including the Quesnel Highlands and possibly Wells Gray Park) or local east-west in the Cariboo Mountains. As noted earlier, the sum of Bloomfield's (1979) probable estimates for the area south of the river was 95-125 animals. However, that must now be revised upward, conservatively to 250 and possibly as high as 300, following the March 1984 survey mentioned earlier (D. King, pers. comm.).

North of the Fraser there are numerous areas of known caribou occurrence, and groups of 20 or more have been seen at several in recent years. There is

also a very large area of the region which is only poorly known as caribou range, and which could harbour caribou groups which have never been recorded. Recent declines in units fronting on the Fraser River, especially 7-17, are likely given the increasing access and human development there, but the big unknown factor in consideration of caribou is the potential immigration and emigration with more pristine ranges to the north. Overall, the five Omineca GMU's north of the Fraser (7-3, 16, 17, 18 and 23) probably support, at least seasonally, a few hundred caribou. Interchange with units still farther north (Peace subregion) is likely.

The harvest and management history for the Omineca subregion is not available in sufficient detail to enable full discussion by GMU's. Most of the area discussed above was administered as GMA 20 in the period 1956-1966, during which time seasons gradually increased from a very conservative 21 day males-only regulation to seasons of over 100 days, including 70-80 days open to taking of either sex. In the administrative change to MA's in 1967, the area including present GMU's 7-1 and 7-2 were put into MA 9 (Big Bend), present GMU 7-23 went into MA 21 (Finlay-Parsnip) and the remainder became MA 20 (Upper Fraser).

Harvest trends for locations within 7-1, 7-2 and 7-23 for years through 1974 can not be determined with certainty because the kill in each would have been an unknown fraction of the total estimated kill for the whole MA's of which they were parts. As shown in Table 9, the trend in MA 9 during that time was generally to decreasing numbers of hunters having only sporadic success. The low kill in the whole area indicates that the reported kill in 7-1 and 7-2 was also low. In MA 21, hunter interest and success remained relatively high through 1975, apparently peaking in 1973. The kill for that year, 91 animals, was distributed over an area of which present GMU 7-23 constituted less than 10%. The kill was probably not strictly proportional to area, and the degree of departure is not known. However, the area of present 7-23 was not significantly more accessible than the rest of MA 21 at that time, and there is little reason to suspect that the percentage of the total kill attributable to that area was large.

It is generally believed that hunting played a major role in the apparent decline of caribou in the rest of the area of interest here, i.e., old MA 20. Bloomfield's (1979) discussion on that subject is, itself, a fine example of

TABLE 9. Harvest statistics for caribou in southern Region, 7, 1964-1975. Data from Hunter Sample, B.C. Fish and Wildlife Branch, Victoria, B.C.

Management Area ^a (MA)	Year	Number Res. Hunters ^b	Res. ^b Kill	Success (Percent)	Percent Male(N) ^c	Guided Kill ^d
<u>GMA/MA 20</u>	1964	397	139	35.0	79(71)	-
	1965	508	177	34.8	75(88)	66
	1966	689	228	33.1	77(96)	104
	1967	489	121	24.7	50(38)	30
	1968	299	58	19.4	72(18)	-
	1969	427	98	23.0	69(29)	-
	1970	301	78	25.9	81(27)	19
	1971	258	76	29.5	-	-
	1972	258	40	15.5	58(12)	-
	1973	303	50	16.5	100(15)	-
	1974	170	21	12.3	100(5)	2
	1975	113	4	3.5	100(1)	-
<u>MA 9</u>	1967	19	3	15.8	0(1)	0
	1968	29	16	55.1	57(7)	-
	1969	13	0	0	-	-
	1970	25	2	8.0	100(1)	0
	1971	12	8	66.7	-	-
	1972	15	0	0	-	-
	1973	10	0	0	-	-
	1974	15	4	26.7	100(2)	0
	1975	1	0	0	-	-
<u>MA 21</u>	1967	261	50	19.2	75(16)	12
	1968	295	65	22.0	90(20)	-
	1969	244	50	20.5	92(13)	-
	1970	171	33	19.3	100(11)	47
	1971	183	45	24.6	-	-
	1972	251	71	28.3	82(22)	-
	1973	358	91	25.4	100(29)	-
	1974	215	41	19.1	100(11)	30
	1975	225	57	25.3	100(21)	-

^aAreas: GMA 20 (1956-1966)- included present GMU's 6-1,6-2,6-4,7-1 to 7-9,7-12, 7-16 to 7-18, part of 7-23; MA 20(1967-1974)-present GMU's 7-3 to 7-9,7-17; MA 9(1967-1974) - present GMU's 4-36 to 4-40,7-1, and 7-2; MA 21(1967-1974)-all or parts of present GMU's 7-16,7-23,7-24,7-28 to 7-30, 7-37 to 7-41.

^bEstimated from sample questionnaires

^cN = sample size (No. of animals reported)

^dGuided kill: from summaries presented in Hunter Sample for years indicated. Figures include at least some animals taken by residents. Data for other years not available.

overkill. His primary evidence was subjective, consisting of a long list of quotes from local people who believed that harvests and/or hunting pressure had been excessive. Interestingly, some of those same observers had also responded, in his questionnaire, that they believed wolf predation had been significant in the area but he considered their input on that subject to have been "coincidental and inferential."

Bloomfield (1979:214) reported that "Liberal hunting regulations contributed to a general population decline through harvests of calf-producing females, a reduction in caribou numbers, alterations in population structure and damage to social traditions ..." and that "... breeding success declined ..." and "... mortality exceeded recruitment on a regular basis." All of the above points are valid as hypotheses, but none are clearly descriptive of what happened, since none are supported by data. Bloomfield argued that Hunter Sample figures on the sex ratio of the kill were not reliable because preferences of hunters for males led them to report that sex even when they actually shot females. That would have resulted in a higher kill of females than managers knew about. Yet, he also argued that a number of factors, including hunter preference for males, resulted in an overharvest of males and a subsequent distortion of sex ratio which led to reduced breeding success. In the absence of significant data, for any year, on actual population size or composition, his arguments remain speculative.

Bergerud (1978) used a somewhat more objective approach, indicating that harvest data (Hunter Sample) from MA 20 represented "one of the clearest examples of overharvest." The data, as listed in Table 9, are indeed suggestive but are not conclusive when examined closely. Bergerud points to a "91% decrease" in harvest (121 to 12) and an "88% change" in success rate (34% to 4%) between 1967 and 1976 to illustrate his case. However, use of those figures over-dramatizes the situation since it does not acknowledge the potential effects of some important management changes in the early 1970's. Chief among those were closure of the either sex regulation, beginning in 1973, and outlawing the use of helicopters for hunting in 1972. Doubling of the caribou tag license fee (to \$10) in 1974, and complete closure of GMU's 7, 8, 9, and 16 in 1975 both would have reduced hunter interest in the area, and the latter, at least, should also have reduced the kill.

To demonstrate the role of hunting in depressing caribou numbers in MA 20, Bergerud (1978) constructed a model, beginning with an estimated population of 600-625 animals in 1967. Table 10 lists his most optimistic calculated results for mortality, recruitment, and numbers through 1977, showing a decline to about 225 animals by that year. However, that result is shown to be an oversimplification by the additional information in Table 10, which makes Bergerud's estimates sex specific on the basis of recorded kill data (Hunter Sample) and conservative application of caribou population dynamics data from Bergerud (1980). The population composition projections produce the rather startling conclusion that the kill in 1971 removed 20 more males than were available. Further, the male kill in the following 2 years was estimated (Hunter Sample) at 23 and 50, respectively. As was the case for data from other regions, it simply is not possible to characterize the rise and fall of populations without at least one reliable count and accurate information on recruitment and mortality.

In this case there are a variety of possible deficiencies in the data upon which Table 10 is based, including an initial (1967) population estimate which was too low, an initial bull complement which was unexpectedly high despite several years of long hunting seasons, inaccurate Hunter Sample data (underestimated total kill; overestimated bull component) or estimates which were consistently incorrect for recruitment, poaching and natural mortality. Any or all could have been in effect for any or all of the years indicated.

In addition to those specific data concerns there are some general aspects of Bergerud's model that should be mentioned. As for the other regions, the guided kill for the early years is not completely additive to the Hunter Sample kill figure because at least some of the guided hunters were residents. The recruitment rate used -- 17% "because (the caribou) live in an area of relatively low wolf numbers" may be a serious oversimplification both because a constant rate from year to year is unlikely and because it ignores the possibility that factors other than predation (e.g. declining males, hard winters, loss of important range) might have influenced it. Finally, the method in which Bergerud calculated the total population each year actually hastened the apparent decline. He subtracted all mortality from the previous year's population before calculating recruitment in each case. If the recruitment had been calculated prior to subtracting mortality (perhaps a more

TABLE 10. Hypothetical decline of MA 20 caribou. Table organization, methods of calculations and data in T (Totals) columns from Bergerud (1978).

Year	Population		Mortality (number of animals)															Natural mortality		
			Recruitment			Guided kill			Resident kill			Poaching								
	ma	fa	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T		
1967	238	387	625	48	40	88	10	5	15	60	61	121	10	15	25	22	10	32		
1968	184	336	520	37	31	68	10	5	15	42	16	58	7	13	20	19	9	28		
1969	143	335	478	31	25	56	7	4	11	68	30	98	4	11	15	18	8	26		
1970	77	319	396	26	21	47	9	5	14	63	15	78	2	8	10	12	6	18		
1971	17	312	329	20	17	37	10	5	15	38 ^b	38 ^b	76	0	5	5	9	4	13		
1972 ^d	(-20)	-	261	-	-	-	-	-	7	-	-	50 ^c	0	5	5	8	3	11		
1973 ^e	-	-	233	-	-	-	-	-	10	-	-	40 ^c	-	-	-	8	3	11		
1974			194						?			21			-	6	2	8		
1975			194						?			4			-	6	3	9		
1976			213						?			12			-	6	3	9		
1977			225						-			-			-			?		

a sex specific data (M=male, F=female) calculated or from sources as follows: Population, year 1 - 38% male which is maximum observed for male component in British Columbia, as listed in Bergerud (1980); Recruitment - 55% male = maximum proportion of males among animals to 17 months in Bergerud (1980); Guided kill - conservatively assumed two-thirds male; Resident Kill - from Hunter Sample unless indicated otherwise; Poaching - sex composition of the kill assumed to be in same proportion as sex ratio of population; Natural mortality - 69% male, based on reported rate of sex specific mortality in a herd with little predation on adults (Bergerud 1980).

b Actual data not available - conservatively assumed 50:50

c These total kill figures reversed by Bergerud (1978), i.e., there were 40 (58% male) in 1972 and 50 (100% male) in 1973.

d No further calculations possible because males already depleted.

realistic procedure considering the supposition that most mortality occurred during the fall hunting season), the total projected population figures for 1968-1972, respectively, would have been 560, 534, 475, 436, and 383. The last figure is 47% higher than its counterpart (261) in Table 10.

As indicated above, the only real data available to reviewers of history and population dynamics of caribou in the Upper Fraser area are figures on hunting pressure and kill. The discussion in Section 4.2., which uses MA 20 data as examples, suggests that even the hunting information can not be fully trusted. Compulsory inspection is the data gathering system which appears to provide the most specific and reliable local kill data. Ironically, by the time it was introduced for caribou (1978), all of the GMU's discussed above had been closed to hunting.

2.8.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Maps 6a, 8a, 9a, 11a, 12a, 13a, 15a): Caribou commonly use high-elevation Engelmann spruce - subalpine fir forests during this period, when snow conditions permit. Arboreal lichens are the main forage item in that habitat in late winter. Many of the high elevation ranges have been identified, but others are poorly known, especially along the northern and eastern borders of the subregion.

During some winters (e.g. 1976-77, 1980-81) caribou apparently use low-elevation forests well into the late winter period, probably due to poor snow support. Even at times when the snowpack has settled and other caribou are on high-elevation ranges, some animals are observed regularly at low elevations. It is unclear whether those low-elevation sightings represent primarily animals moving from one high-elevation range to another, or whether some individuals remain low throughout the winter.

In Jasper National Park (Stelfox and Jasper Warden Service 1974; Stelfox et al. 1978), in Willmore Wilderness Area (Bloomfield et al. 1981), and east of the Rocky Mountains in the Peace subregion (Section 2.9), some caribou spend the late winter period in open alpine and subalpine habitats, where they crater for terrestrial lichens and vascular plants. This pattern probably occurs less frequently in adjacent parts of the Omineca subregion, as the snowpack at high elevations west of the Rocky Mountains is usually too

deep for cratering. However, in March 1982 caribou cratered through snow on Burden Peak to feed on Salix sp., the rock lichens Umbilicaria spp., and the terrestrial lichens Stereocaulon spp. and Cladina spp. (D. Stevenson, pers. comm.). Toward the end of the winter period, when alpine ridges become free of snow, caribou feed on exposed terrestrial vegetation.

Spring: Bloomfield (1979) reported a movement to low-elevation forests at this time, where caribou fed on fresh green vegetation. Mapped observations indicate that caribou are commonly seen in the same areas they frequent during early winter. During some years, some animals remain high and feed on exposed alpine vegetation. Caribou are often seen on slides during this period.

Calving: Little information is available on calving areas. The only documented calving site in the subregion is a barren alpine slope in the McGregor Mountains, where placental material was found in the fecal pellets of a cow caribou (Child 1978b). Some residents east of Prince George believe that calving occurs in low-elevation forested muskegs (Bloomfield 1979). Of the 14 relocations of radio-collared cows that were obtained during calving season in the British Columbia-Alberta border area, five were in open alpine, three were at timberline, and six were in subalpine forests. Snow cover ranged from 25 to 75% (Edmonds and Bloomfield 1984.).

Summer: Summer range is typically alpine and subalpine meadows, timberline forests, and snowfields. Bloomfield (1979) reported summer use of forbs (e.g. Caltha leptosepala, Pedicularis bracteosa, Trollius laxus), sedges and grasses, horsetails (Equisetum spp.), and willow (Salix spp.).

Many summer ranges are the same as late winter ranges. Along the eastern border of the subregion are some rugged mountainous areas where most sightings have been made in summer. At least some of the caribou using those summer ranges winter in Alberta on the eastern slopes of the Rocky Mountains (M. Bloomfield, J. Edmonds, pers. comm.).

Caribou are sometimes seen at low elevations during this season, though less commonly than during spring or fall.

Rutting areas: Rutting areas are poorly known. Bloomfield (1979) reported that the rut was largely localized in timberline meadows and krummholz. He also reported a number of sites believed by local residents to be rutting areas; about half of these were located above timberline and about half in valley bottoms.

Edmonds and Bloomfield (1984) surveyed rutting caribou in the mountains of Willmore Wilderness Area, Jasper National Park, and adjacent British Columbia in September and October of 1981, 1982, and 1983. Of 67 caribou observations during the rut, 40% were in open alpine meadows and ridges, 47% were in krummholz, and 13% were in subalpine forest. Rutting areas in British Columbia were located at the headwaters of the Morkill River, on a ridge east of Wallop Creek, on Intersection Mountain, and on Wishaw Mountain.

Fall/early winter (Vol. 2, Maps 6a, 8a, 9a, 11a, 12a, 13a, 15a): During this period caribou are often seen in low-elevation forests, probably when soft snow limits mobility at higher elevations. A large proportion of the observations reported by Bloomfield (1979) was below 1000 m, in spruce - subalpine fir and cedar - hemlock types. Forage items included forbs, arboreal and terrestrial lichens, and shrubs.

Near the junction of Highway 97 and the Mackenzie access road, caribou have been observed during several winters in lodgepole pine and lodgepole pine-white spruce forests on the Parsnip River flats (Fish and Wildlife Branch files). What the animals fed on was not reported, but terrestrial lichens (Cladina spp. and Stereocaulon spp.) are abundant and arboreal lichens moderately abundant in the area. Most observations were in January and February. If the animals later moved to a high-elevation range, it is unknown.

In general, low-elevation winter ranges have not been adequately identified in the subregion. The Fraser valley between the McKale and Morkill Rivers is a well-known winter range but, even there, factors influencing habitat selection are poorly known.

Movement routes and special habitats: Movement routes and licks believed to be currently in use are shown on Maps 6a, 8a, 9a, 11a, 12a, 13a, and 15a (Vol. 2). Bloomfield (1979) mapped historically known movement routes and licks as well.

Caribou move between British Columbia and Alberta north of Highway 16, and probably south of the highway as well. In an Alberta Fish and Wildlife Division study, caribou were radio-collared during winter in the foothills region of Alberta to the east or north of Grande Cache. Ten of the 28 collared animals moved into British Columbia for all or part of the calving, summering, and rutting season. Straight-line distances between winter and summer ranges were up to 153 km (J. Edmonds, pers. comm.).

Factors affecting caribou habitat

Logging: A variety of logging systems has been used in the Prince George area in a continuing effort to achieve natural regeneration or, later, satisfactory conditions for planting (L. Merkel, G. Talbot, pers. comm.).

Diameter limit logging was the earliest logging system used in the region, and was still in use in the 1950's in some areas. Most of that early logging was located in valley bottoms close to roads. Twelve inches was the usual diameter limit. That system commonly resulted in large amounts of residual subalpine fir. Occasional blowdown was common, especially where some spruce was left.

Single tree selection was used from the early 1950's until about 1956-57. The object was to remove about 50% of the volume or of the stems, depending on stand structure. That system was used near roads in the Naver, Willow, and Crooked River PSYU's. Blowdown and genetic inferiority of the residual stand were problems that resulted from that logging system.

Five-chain cut-and-leave strips were used from the mid-1950's to the mid-1960's. The timber along the edges of the residual strips often blew down into the regeneration. Control of slash fires was a major problem with that system. After the first pass, slash fires tended to spread into the leave strips. When the leave strips were removed in a second pass, the regeneration in the previously logged strips often burned as well. Some of the areas originally logged in that fashion still remain in a partially cut condition.

Five-acre seed blocks were often left in clearcuts in the late 1950's and early 1960's. Those often blew down within a few years, leaving natural regeneration in the cutblock if a good seed year had occurred first. As those 5-acre blocks were not usually logged in a second pass, their volume was often unused.

Two changes that affected logging systems occurred in the 1960's. The introduction of close utilization standards in 1966 resulted in harvesting to a 7.1-in. (18.0-cm) diameter cut-off, rather than the 11.1-in. (28.2-cm) limit observed under intermediate utilization standards. After the establishment of a nursery in 1967, there was less emphasis on achieving natural regeneration, and more emphasis on planting.

Since the late 1960's, nearly all logging has been clearcutting to close utilization standards. In theory, clearcuts are generally planned for around 80 ha, which is considered the optimum compromise among the requirements of forest protection, silviculture, and other resources. However, many recent clearcuts have been much larger, especially in areas of beetle attack.

Silvicultural guidelines for the Prince George Forest Region have been described by Revel and Fraser (1981). On most spruce - subalpine fir sites in the SBS zone, the usual silvicultural prescription is to clearcut, broadcast burn, and plant immediately with spruce. If broadcast burning is not feasible, windrowing and burning or mechanical site preparation may be used. Natural regeneration may be attempted under ideal conditions, but advance regeneration of subalpine fir is not usually used for the next crop.

Spruce sites in the ESSF zone are also clearcut, broadcast burned, and planted with spruce. Subalpine fir forests in that zone are considered watershed forests, in which natural drainage fundamental to lower forests must be maintained. Selective logging to preserve advanced regeneration and small poles and trees is recommended. That prescription is not currently practised, because high-elevation subalpine fir stands are not being harvested (A. Todd, pers. comm.).

In the ICH zone, clearcutting is prescribed for all forest types except immature Douglas-fir stands, which may be commercially thinned. Felling of hemlock is recommended even if it cannot be used for chips. Site preparation is accomplished by broadcast burning or windrowing and burning, and spruce, Douglas-fir, or lodgepole pine is planted. On cedar and cedar-spruce types, spacing of seedlings is wide to allow for natural fill-in of cedar.

Lodgepole pine types are clearcut, scarified, and allowed to regenerate naturally. Dense stocking is expected to be a problem, and experimentation with techniques for stocking control is planned. At present, most juvenile

spacing in lodgepole pine is done in 15- to 20 year-old stands which originated after fire (A. Todd, pers. comm.).

Major silvicultural problems in this part of the region are windthrow, bark beetle infestations, site preparation difficulties, and dense brush after harvesting. Overmature stands of spruce, cedar and hemlock are presently occupying good growing sites, and it is a major silvicultural goal to harvest and plant in those areas.

Transportation corridors and access: Most major drainages south of the Fraser River have some road access, though few logging roads extend to high elevations. Major areas presently without road access are most of the Haggen Creek drainage, the Milk, upper Goat, and Raush rivers, and the Kinbasket Lake area south of Horse Creek on the east, and a point opposite Ptarmigan Creek on the west. The Goat River and Haggen Creek are under development.

North of the Fraser River, development is under way in the Herrick Creek drainage, and access is planned in the Morkill watershed. Although the upper Macgregor River has not yet been logged, an all-weather mining road to the Macgregor Pass area is under construction. A number of smaller tributaries, such as Jarvis Creek, Fontoniko Creek, and James Creek, are still without access.

Of the major tributaries of the Parsnip, the Table and Anzac rivers have major access roads, and the lower portion of the Missinka has been developed. The Hominka River has not yet been logged, but a development plan is in place. A few smaller drainages, such as the Woodyadalinka and upper Parsnip, have no access. The new Anzac-Tumbler Ridge railway passes near areas of known caribou use, and may create a collision hazard.

Two major transportation corridors, Highway 16 and the Canadian National Railway, are located along the Rocky Mountain Trench. Both have been the cause of some caribou mortality. Vehicle collisions with caribou occur sporadically along Highway 16, especially during spring and early winter. Caribou, like other ungulates, are attracted to salted highways. In early January 1982, at least 17 and perhaps as many as 30 caribou were killed along the CN tracks between Hutton and Longworth after being struck by a snowplough and a freight train. That occurred during a period of deep powder snow (K. Child, pers. comm.).

Fire history (Vol. 2, Maps 6b, 8c, 9c, 11b, 12b, 13b, 15b): A number of fires, some of which were large, occurred during the 1960's in the Prince George Forest Region. The Grove Burn, just east of Prince George, and a large fire in the Bowron River valley south of Purden Lake, affected areas that were low-elevation range for caribou. Other major fires during this era burned both high- and low-elevation areas within caribou range: the North Anzac River, the north side of Haggan Creek, Castle Creek, and the Chalco Creek-Holmes River system. In 1981, several areas along the south side of the Dezaiko Range burned nearly to timberline, affecting known caribou ranges.

Insect attack (Vol. 2, Maps 6c, 8d, 9c, 11b, 12b, 15c): A major spruce beetle epidemic has been ongoing in the southern part of the Prince George Forest Region since the first large flight of beetles in 1979. In 1981, 50,100 ha of beetle attack were mapped by the Canadian Forestry Service in Prince George East, which includes roughly the western half of the caribou ranges under discussion (R. Cozens, pers. comm.). The areas of most severe attack are the Bowron River valley and adjacent drainages, and the upper McGregor-Bastille Creek area. Most harvesting efforts are presently directed toward the Bowron area, as current market conditions make logging unfeasible in the upper McGregor (D. Williams, pers. comm.). Except for the Bowron valley bottom, both areas support caribou.

Many small areas of spruce beetle attack are present in the George Mountain area and along the south side of the Fraser River as far east as Legrand creek, but the area of attack is not expanding as much as in the Bowron. Harvesting of beetle-killed timber is considered a management problem in the West Twin area (K. Child, pers. comm.). North of the Fraser River, infestations exist from McLeod Lake to the lower Morkill River, but they are spreading rapidly only in the upper McGregor-Bastille area.

Mountain pine beetle is a problem near Valemount and along Kinbasket Lake but not generally in areas used by caribou.

Other developments and human activities: Prospecting and mining are ubiquitous in the region and have been responsible for some access development. As environmental impact studies of Kinbasket Lake were not undertaken until after the creation of the reservoir, its effects on caribou

are uncertain. The Environment and Land Use Committee (1974) estimated that a 10% reduction in the population occurred, but their assessment was based on little information.

Where access to high elevations has been developed near populated areas, use of caribou ranges by snowmobilers is a problem. Alpine caribou ranges are being used by snowmobilers near Mackenzie, Prince George, McBride, and Valemount. In Prince George, Habitat Protection staff worked together with the Recreation Branch of the Ministry of Forests and the Prince George Snowmobile Club to select an area to be designated as a Forest Recreation Area for snowmobiling. All areas that were considered support caribou, including the final selection, George Mountain. Habitat Protection staff felt that encouragement of snowmachine use in a single area would help prevent its proliferation into all accessible alpine caribou ranges (Fish and Wildlife Branch files). However, snowmobile activity is still a problem in many caribou ranges (D. King, pers. comm.).

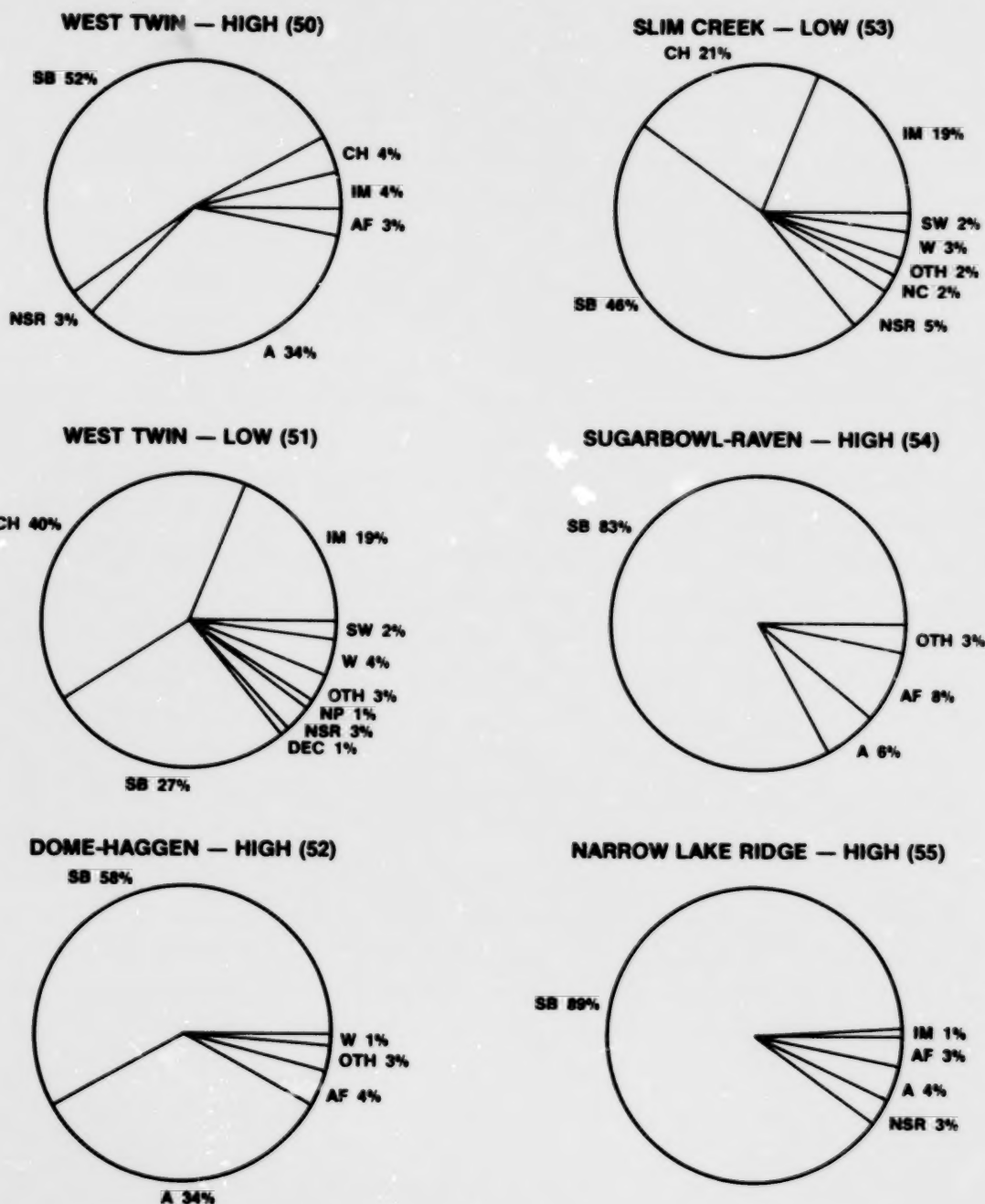
Status of habitat in caribou ranges

Only four low-elevation ranges were mapped in this subregion (Fig. 10). The three that are located in the Fraser River drainage (No.'s 51, 53, and 58) are composed of immature timber (19-39%), cedar - hemlock (21-40%), and spruce-balsam (21-46%). In contrast, Mackenzie Flats is made up largely of immature timber (mostly lodgepole pine) and mature lodgepole pine. All four ranges have sustained logging.

The high-elevation winter ranges in the subregion are composed of spruce-balsam, alpine forest, and alpine, in varying proportions. To some extent, those varying proportions may be an artifact of boundary placement, but in most cases they appear to reflect real differences in topography -- the elevations and shapes of the mountains. Unlike the low-elevation ranges, the high-elevation ranges in the subregion characteristically have a low percentage of immature timber. George Mountain, with 15% immature timber and 5% not sufficiently restocked, is the only exception.

Of the high-elevation ranges south of the Fraser River, West Twin, Narrow Lake Ridge, Sugarbowl-Raven, and George Mountain have sustained some logging, and harvesting is underway in Dome-Haggen. In the McGregor River area north of the Fraser, extensive logging in the valley bottoms has extended into the

**FIGURE 10. Status of habitat in caribou ranges:
Region 7-Omineca.**



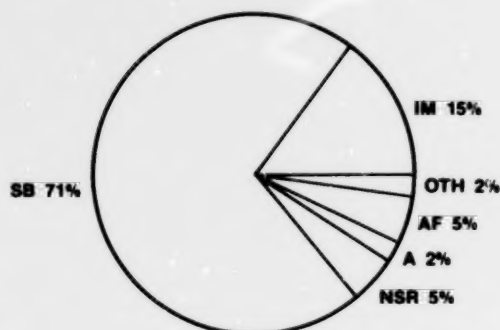
LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

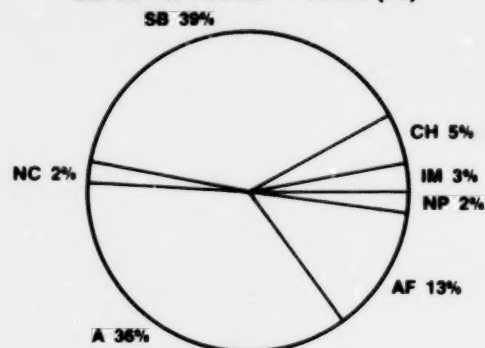
Categories with less than 1% are grouped into OTH

**FIGURE 10. Status of habitat in caribou ranges:
Region 7-Omineca (continued).**

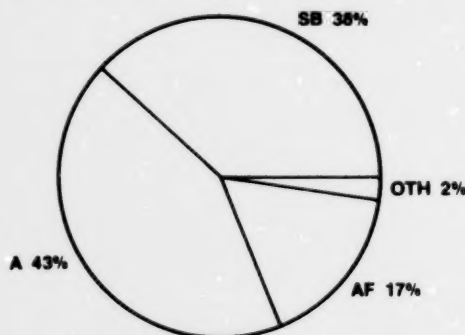
GEORGE MOUNTAIN — HIGH (56)



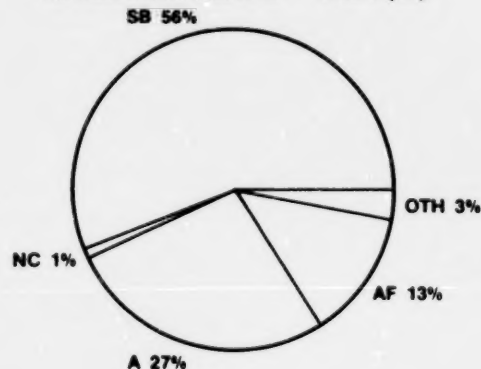
BEARPAW RIDGE — HIGH (59)



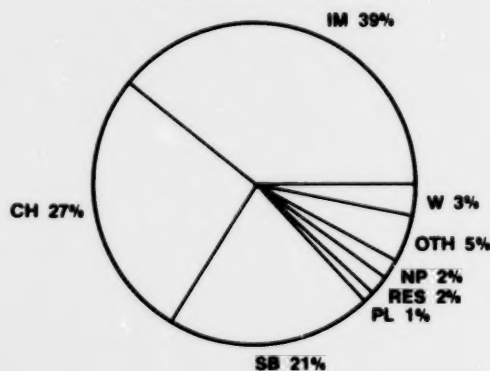
WALKER-McGREGOR — HIGH (57)



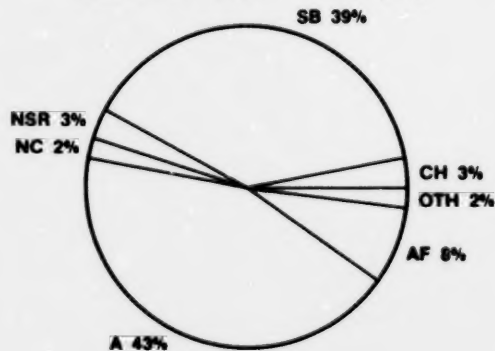
McGREGOR RANGE — HIGH (60)



LONGWORTH — LOW (58)



DEZAIKO RANGE — HIGH (61)

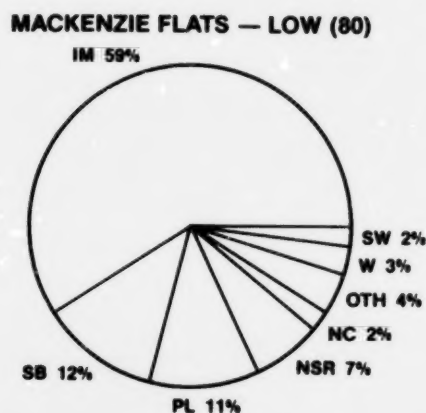
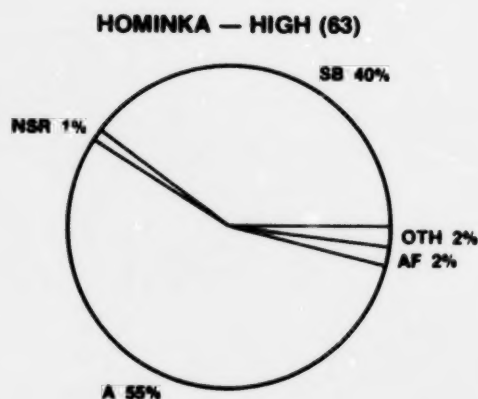
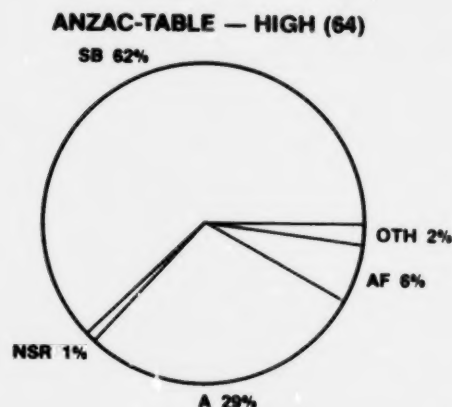
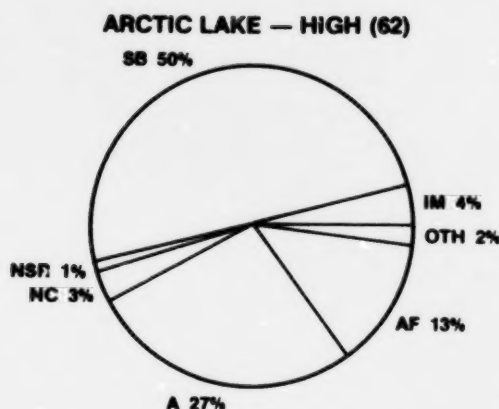


LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

**FIGURE 10. Status of habitat in caribou ranges:
Region 7-Omineca (continued).**



LEGEND			
IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

high-elevation ranges (No.'s 57, 59, 60, 61, and 62). The Hominka and Anzac-Table ranges are currently unlogged.

Those portions of the McGregor Range and Bearpaw Ridge caribou ranges that fall within TFL 30 are not included in the Mark IV data base.

Forest management planning

Caribou ranges in the study area west of the Rocky Mountain divide are located mainly in the McBride and Prince George TSA's. The extreme northwest corner of the study area is located in the Mackenzie TSA, but the area is so small that the Mackenzie TSA is not discussed here.

The 20-year timber supply in the McBride TSA is adequate (Table 2). A falldown after 70 years, which was projected in the Yield Analysis Report (Prince George Forest Region 1980), was effectively eliminated when the Morkill drainage was shifted from the Prince George TSA to the McBride TSA (AAC Determination, McBride TSA, 15 December 1980). The AAC now closely approximates the Long Run Sustained Yield, and can be maintained throughout the 200-year look-ahead period (B.C. Ministry of Forests 1983).

One of the major management problems in the McBride TSA is the necessity of logging old-growth timber in remote areas. Until recently, most logging has been in accessible, low-elevation stands where development costs are low. Much of the future harvesting will be in more rugged terrain, where road development costs will be higher, and where more specialized, expensive harvesting systems will be required (L. Merkel, pers. comm.; Prince George Forest Region 1980). Maintenance of the projected harvest rates depends on access development in the more difficult operating areas, and on utilization of existing old-growth timber (Allowable Annual Cut Determination, McBride TSA, 15 December 1980).

According to the Yield Analysis Report for the Prince George TSA (Prince George Forest Region 1979), the timber supply is adequate to maintain 1979 commitment levels both in the short term (20 years) and the long term (beyond 20 years). An increased timber supply was projected for the next 105 years, after which the supply would fall to a level intermediate between the 1979 commitment and the Long Run Sustained Yield. The Yield Analysis Report was based on 1979 TSA boundaries; the Morkill drainage was later transferred to the McBride TSA. The AAC (Allowable Annual Cut Determination, Prince George

Timber Supply Area, January 1981) was set at 8 605 000 m³ -- 13% higher than the 1979 commitment level, despite the reduced area of the TSA. The harvest rate was chosen in order to minimize losses in overmature stands and to improve overall age class distributions. For that harvest rate to be maintained, industry will be required to increase the proportion of the cut composed of subalpine fir. According to the most recent analysis of the timber supply (B.C. Ministry of Forests 1983), the current AAC is within 5% of the Long Run Sustained Yield.

The Prince George TSA comprises several supply blocks in the south in which considerable logging has already taken place, and several less-developed supply blocks in the north. The current spruce beetle infestation is localized in the southern portion of the TSA. The study area lies within the southern supply blocks. Although the timber supply picture for the TSA as a whole looks good, local supply problems could occur within the study area.

Habitat protection

Until recently, Fish and Wildlife Branch input into logging plans was handled through folio planning and through the referral process. Habitat Protection staff developed a system of habitat capability mapping which was applied in parts of the subregion in which folio planning was carried out. At present, the folio planning system is rarely used, although the maps and associated guidelines are used for reference by Habitat Protection staff.

The referral process gives Habitat Protection staff the opportunity to recommend changes to specific cutblock proposals. Habitat protection measures handled through referrals have focussed mainly on the Cariboo Mountains and the Macgregor Mountains, where caribou are relatively abundant, and logging relatively widespread. In those areas, habitat protection staff have attempted to maintain corridors of mature timber across valleys, and to limit cutblocks to 80 ha or less. The Morkill River, Haggan Creek, and the Goat River are under development and are likely to become major areas of concern. Caribou are fairly common in those watersheds, but little information is available on habitat use (D. King, pers. comm.).

In addition to specific cutblock proposals, the Fish and Wildlife Branch has input into TSA plans and 5-year development plans. At the TSA level, Habitat Protection staff have suggested changes to the boundaries of the

20-year interest areas assigned to logging companies. At the development plan level, they review the proposed layout and scheduling of cutblocks for the upcoming 5-year period.

2.8.3. Information needs

High-elevation ranges in the subregion are generally better known than low-elevation ranges, except along the Fraser Valley between the Morkill and McKale rivers. The need for better information on habitat requirements of caribou, especially in lower and mid-elevation areas, is acute. Habitat requirements for rutting and calving are poorly known. Information is needed on methods for reducing collision mortality along highways and rail lines.

2.8.4 Information base

Aerial surveys

CLI, RAB, TSB

83D: 12/69, 1&2/70

93G: 1&2/67

93H: 1&2/69, 1/14, 17-19/78

93I: 1/24-28/69, 6/7, 8, 23/76, 7/30/76, 8/10/76,
10/19-20/76, 11/16, 30/76, 12/14, 18-19/76,
1/21-22, 25-26/77, 2/1-3, 17-19/77, 3/7, 9-10/77,
5/24/77, 9/18-20/77, 10/2-3/77, 12/11-13/77,
1/13-19/78, 3/11/82

93J: 1&2/66, 1/17/78, 3/11/82

93O: 1&2/66, 3/6-8/74

M.I. Bloomfield, M.Sc. thesis on ecology and status of caribou east of Prince George 1975-1977.

Major activities: Aerial surveys, ground surveys, interviews with residents, observations of feeding sites, fecal fragment analysis, vegetation classification.

Reports: Bloomfield (1979, 1980a, 1980b); Bloomfield and Bloomfield (1981).

Resource Analysis Branch, Northeast Coal Studies 1976-78

Major Activities: Aerial surveys, ground inspection, interviews, biophysical capability mapping, identification of wildlife habitat associations, impact assessment.

Reports: B.C. Ministry of Environment, Resource Analysis Branch (1977, 1979); Environment and Land Use Sub-Committee (1977, 1978).

B.C. Hydro environmental impact study of proposed McGregor Diversion

Major activities: Aerial surveys, interviews, mapping of caribou ranges, impact assessment.

Reports: Reid, Crowther and Partners Ltd. (1978).

Guide-outfitter interviews, Fish and Wildlife Branch summer student project 1973-74.

Major activities: Interviewing guides, mapping caribou ranges as reported by guides.

Incidental sightings: About 475. Major sources R. Weinard, K. Child, D. King, G. Hazelwood, S. Stevenson.

Miscellaneous reports

Theberge (1976) - Assessment of West Twin-Ptarmigan Creek area as a possible Ecological Reserve.

Child (1978b) - Report of placental material found in fecal pellets of cow caribou.

Environment and Land Use Committee (1974) - Assessment of resource problems and effects of Mica Reservoir; caribou information is general.

Hazelwood and MacKinnon (1982) - Review of information on caribou ranges in Rocky Mountain Trench.

Caribou research in adjacent Alberta

Canadian Wildlife Service-Parks Canada studies of caribou in Jasper National Park

Major activities: Ground observations, vegetation classification, biomass sampling and utilization ratings of forage plants, pellet group counts, fecal fragment analysis, feeding crater observations, behavioural observations.

Reports: Stelfox and Jasper Warden Service (1974); Stelfox and Bindernagel (1978); Stelfox, Kuchar and Bindernagel (1978).

Alberta Fish and Wildlife Division studies of caribou in the Berland-A La Pêche area, Alberta 1980 to present.

Major activities: Vegetation classification, lichen abundance estimates, fecal fragment analysis, crater descriptions, questionnaires and interviews, radiotelemetry, aerial and ground surveys, behavioural observations, blood and other tissue sampling, weather monitoring, predator scat analysis.

Reports: Bloomfield et al. (1981); Edmonds (1981, 1982); Edmonds and Bloomfield (1981, 1984).

2.9 Prince George Forest Region - Fish and Wildlife Region 7: (Peace Subregion)¹

2.9.1 Caribou populations

Distribution

Broad distribution (Fig. 1; Vol. 2, Maps 9a, 9b, 10a, 13a): Caribou are present throughout the subregion within the study area except for the Alberta Plateau, where they occur only in the south (e.g. Hourglass Lake, Blackhawk Lake, Sunderman Creek). They are also widespread in the mountains north of the study area boundary.

Historic changes in distribution: We have no information.

¹Parts of the Prince George Forest Region lying west of the Rocky Mountain divide are discussed in Section 2.8.

Numbers, status and management

Churchill and Harper (1979) stated that it was impossible to assess numbers of animals in the general "Northeast Coal" study area both because information on past numbers was lacking and because of "the inability of present inventory techniques to quantify such mobile animals in such low densities." As has been evident in preceding sections of this report, that difficulty is not unique to the Northeast Coal area. The above authors generated an estimate of 260 animals in the area, in winter, by reference to a series of 13 caribou sub-units, one of which lay outside of our study area. Because there are few data overall, giving little basis for subdividing populations, our following analysis is by GMU's. We emphasize that interchange and overlap between those units certainly occurs.

1. GMU 7-19

The relatively few sightings in this unit are mostly distributed into three clumps. Proceeding from the south, the first of those is in the upper Narraway River area. A group of 67 was said to have ranged through the uplands there and in adjacent GMU 7-18 during all seasons in 1962 (Bloomfield 1979, Appendix F), but there were no other recorded observations for the area until December 1976 (13 in the Saxon Ridge area). The largest recent count was 24, in four groups, during surveys on 2-3 October 1977, and that figure was known to be minimal since tracks were seen at other locations during the same flight. It is a virtual certainty that the animals in that area regularly cross the height-of-land boundary between 7-18 and 7-19, and seasonal movements across the British Columbia-Alberta border have been confirmed by the Alberta radiotelemetry studies (R. Wynes, pers. comm.).

The second clump of sightings, between the Belcourt and Red Deer rivers, mostly refer to tracks and a few small groups (one to three animals) seen on late summer-fall surveys in 1976 and 1977. The largest single sighting was 12 animals on Menagin Mountain (near the boundary with 7-18, at the headwaters of Herrick Creek), in February 1977.

The third, and largest, clump is in the northeastern portion of the unit in the vicinity of Wapiti and Onion lakes. The uplands in that area contain the boundary between GMU's 7-19 and 7-21, and movement back and forth across that boundary certainly occurs. A total of 13 animals in four groups

(4,4,3,2) were seen in that area on a survey flight in September 1977, and that constitutes the largest count among our records (Appendix 1).

It is difficult to determine even the minimum number of animals for the entire management unit since the largest counts in each area of concentration were separated in time by at least several weeks. It nevertheless seems likely that more than one herd of caribou occupies the unit at least occasionally, i.e., that sightings in the upper Wapiti probably involved animals different from those observed in the Narraway. In terms of population size categories listed in Table 16, Section 5.3.1, 35-100 seems applicable in 7-19 with present knowledge, although numbers in excess of 100 are possible.

2. GMU 20

There are only a few observations, all in winter and all presumably involving animals that had moved to lowland habitats there from other units in that season. The earliest historical record is of six animals seen along the upper Kiskatinaw River near the boundary with 7-21 in March 1966, and the largest count is of eight animals seen in two groups in the Redwillow River area in January 1969. Observations since then have mostly been of tracks, the single exception being a sighting of three caribou along the South Redwillow River in December 1977.

3. GMU 7-21

There was little recorded information on caribou in this unit through the mid-seventies, but coal exploration and development has focussed attention and increased inventory activity in the area in recent years. The earliest, and largest, count on any one flight appears to be 57 on 23 April 1974. That total included 33 animals in the Bullmoose-Chamberlain area, 19 on Quintette Mountain, and five in the Mount Spieker-Mount Reesor area. As shown in Appendix 1, the next highest count, 35, was attained in 1977. On that occasion (2-3 October), the greatest proportion of the animals sighted in GMU 7-21 was on Mount Spieker (25). In addition on that day, 10 others were seen from west of Quintette Mountain to Onion Lake, 24 were tallied in adjacent areas of 7-19, and tracks were seen at several other locations. It is not clear whether the Bullmoose-Chamberlain area or Mount Reesor were

surveyed at that time, thus the 1977 count can not be compared to the 1974 high count to determine population trend.

As was the case in GMU 7-19, observations in this unit occur in distinct clumps, but whether that reflects animal distribution more than observer effort is uncertain. The southernmost group of observations, that in the Onion Lake-Wapiti Lake area as described in the 7-19 account, includes the only observations in the southern quarter of the unit and in the large, relatively pristine area comprising the northern half of 7-18 and the eastern third of 7-23. There is one other major aggregation of sightings, in the west-central section from the vicinity of Hook Lake north to the Bullmoose-Chamberlain block, on both sides of the 7-21/7-22 boundary. Data presently in hand suggest a GMU 7-21 population of 35-100 animals, although again a larger number is possible.

4. GMU 7-22

Data accumulated to 1980 suggested that the main area of caribou occurrence in this unit was the Bullmoose-Chamberlain area at its eastern boundary. Counts for 7-21 in that area (up to 33 in 1974 and 15 in January 1977) apply also to 7-22. We have record of no other sightings of more than one animal in the rest of the unit until 1981, although notes from a flight on 1 December 1976 indicated presence of track concentrations, near Mount Jilg and Mount Wendt, which were estimated to have involved 5-15 and 15-20 animals, respectively. On 2 March 1981, 25 animals were counted in four groups (5,6,7,7) scattered over uplands in the north half of the unit. Earlier on the same flight 115 caribou had been found on Mount Bickford, north across the Pine River in GMU 7-31, but just a few kilometres from the northeast boundary of 7-22. Another flight, on 29 December 1981, resulted in a count of 56 animals on Mount Bickford, but only four (plus scattered tracks) in 7-22. The relationship, if any, between caribou in 7-31 and those in 7-22 is not known, but the observations indicate that significant numbers occur not far north of 7-22, and that a population figure in excess of 35 is probably applicable to that unit.

Bergerud (1978) referred to the caribou in the GMU's under discussion as "the Northeast Coal herds," and estimated a total of 300 for the area, based on the dispersion of sightings during government surveys between February 1976

and October 1977. He noted that a government official had also estimated 300 animals after surveys in winter 1977-78. That figure is not unrealistic as a total for GMU's 7-19 through 7-22 but, as indicated in the separate accounts for each (above), the surveys Bergerud cites do not actually document more than about 60 in any realistically short time period. Bergerud (1978) concluded that recruitment was high for the area but his analyses, based on combinations of observations from several surveys, ignore the potential effects of duplicate sightings. Among our records, which include the surveys referred to by Bergerud, the largest short-term sample in which juveniles were classified was 16 (5.3% of his estimated population). That count, on 10 March 1977, included 7 juveniles (43.8%), a ratio which is indeed high, but clearly not representative of the population. It should also be recalled there that young-of-the-year are difficult to distinguish "even by October" (Bergerud 1978:21), thus some of the composition data in his amalgamations may be suspect for that reason.

The hunter kill history for GMU's 7-19 through 7-22 is not specifically determinable prior to 1976, because Hunter Sample data for the early years was based on much larger areas. From 1956 through 1966, those units were managed together in GMA 21, which constituted approximately the northern one-third of the province. As shown in Table 11, the estimated kill for that unit, during the three years for which data are available, was 50-60% of the entire provincial totals for those years. The area of present GMU's 7-19 to 7-22 constituted only about 5% of GMA 21, and its share of the kill was possibly even lower than the area comparison would suggest, primarily because of its relatively lesser accessibility prior to coal developments.

Administrative land units for wildlife management became smaller in the north in 1967, and from then through 1974 the area of present GMU's 7-19 through 7-22 constituted the southern one-third of the applicable new unit there (MA 28). Thus, one-third or more of the estimated kills for MA 28, as listed in Table 11, could have been in the area of present concern. As shown, the estimated MA 28 kill in 1967 was enormous, exceeding the average (351) for all of GMA 21 over the previous three years, and constituting the largest MA kill in that year. A substantial proportion of the reported sample in 1967 (59 of 135 = 44%) was females and young animals. In subsequent years, through

TABLE 11. Harvest statistics for caribou in the Peace River area of Region 7, 1964-1975. Data from Hunter Sample, B.C. Fish and Wildlife Branch, Victoria, B.C.

Admin. area ^a	Year	Resident kill ^b			Percent male (N) ^c	Guided kill ^d
		No.	(%)	Rank		
<u>GMA 21:</u>						
	1964	221	(47.5)	1	85 (100)	-
	1965	279	(53.4)	1	81 (129)	289
	1966	499	(62.5)	1	76 (214)	577
<u>GMA 28:</u>						
	1967	387	(32.5)	1	56 (135)	82
	1968	201	(24.2)	2	57 (65)	-
	1969	165	(19.3)	2	70 (50)	-
	1970	210	(22.1)	2	71 (70)	122
	1971	247	(24.7)	2	-	-
	1972	252	(23.3)	2	69 (71)	-
	1973	274	(21.2)	2	69 (68)	-
	1974	72	(13.6)	3	75 (20)	79
	1975	35	(7.0)	5	100 (11)	-

^aAreas: GMA 21 (1956-1966) - northern one-third of province; MA 28 - included present GMU's 7-19 to 7-22, 7-31 to 7-36 and 7-43 to 7-46.

^bKill estimated from sample questionnaires: No. = estimated number; % = proportion of provincial total taken in area indicated; Rank = rank in province among admin. areas producing a caribou kill, where 1 produced highest kill, 2 produced second highest, etc.

^cN = number of animals reported.

^dGuided kill only from summaries in Hunter Sample. Figures include at least some animals taken by residents. Data for other years not available.

1973, MA 28 remained the second most productive unit for caribou kills, and the male component went up to about 70% or higher after 1968.

The reduction in kill after 1973 was probably due at least partly to increasing restrictions on caribou hunting in the area. Included were a 25% reduction in season length for both sexes in 1973 and a further 50% reduction in that for either sex in 1974 (Vol. 2, Appendix 4). However, a significant "die-off" is believed to have occurred in 1972 (F. Harper, pers. comm.). In 1975, with the introduction of GMU's, much of the area was completely closed to caribou hunting (GMU's 7-20, 7-32 to 35, 7-44 to 46) and in the remainder (7-19, 21, 22, 31, 36, 43) the either-sex season was removed. Subsequent changes primarily involved further reductions in season length such that, since 1978, a three-week males only season in late August and the first half of September produces the nearly negligible kill indicated in Table 12.

If the harvest data in Table 11 can be believed, MA 28 sustained an estimated resident kill that averaged 248 animals per year from 1967 through 1973, with the second highest total (274) in the last year of that series, and with the male component holding at nearly 70% at that time. The extreme drop in 1974, to just over 26% of the 1973 estimate, is not likely explained by regulations changes alone. The GMU's 7-19, 21, and 22 constituted at least 50% of the area in former MA 28 that remained open to hunting after 1974. From that, one might infer that those units were considered among the most important caribou producers in the area, and that they might have contributed significantly to indicated harvest trends to 1975. However, on that inference, it is not clear where all the animals from past harvests might have come from, or why the current local population and kill estimates are not higher. It is more likely that events farther north, e.g. in the Pink Mountain-Prophet River area (see Bergerud 1978), were more important than those south of the Peace River in determining and defining trends in MA 28. In short, knowledge of historical hunter harvests in the area of interest is little better than that pertaining to historical populations.

The data from MA 28 (Table 11) had indicated a fairly substantial guided kill (80 animals or more) in the years for which that information was available. The results from Compulsory Inspection in later years suggest that most of those kills were from northern units. None of four kills documented for GMU's 7-19, 21 and 22 between 1978 and 1981 were taken by non-residents,

TABLE 12. Harvest statistics for caribou in the Peace River area of Region 7, 1976 - 1981.
Data are estimated resident kill from the Hunter Sample (HS) and reported resident kill from Compulsory Inspection (CI), B.C. Fish and Wildlife Branch, Victoria, B.C.

FORMER MANAGEMENT AREA (MA) 28									
Year	Total Kill HS (CI)	Inside present study area					Outside ^a		
		GMU 7-9 HS (CI)	GMU 7-21 HS (CI)	GMU 7-22 HS (CI)	All inside HS (CI)	% ^b HS (CI)	HS (CI)	% ^c HS (CI)	
1976	16 (-)	0 (-)	6 (-)	0 (-)	6 (-)	38 (-)	10 (-)	62 (-)	
1977	14 (-)	2 (-)	2 (-)	0 (-)	4 (-)	29 (-)	10 (-)	71 (-)	
1978	2 (2)	0 (0)	0 (0)	2 (1)	2 (1)	100 (50)	0 (1)	0 (50)	
1979	4 (3)	0 (0)	0 (0)	0 (1)	0 (1)	0 (67)	4 (1)	100 (33)	
1980	9 (4)	1 (0)	0 (0)	0 (0)	1 (0)	11 (0)	8 (4)	89 (100)	
1981	7 (6)	2 (0)	0 (2)	0 (0)	2 (2)	29 (67)	5 (4)	71 (33)	

^aOutside refers to sum of data for GMU's 7-31, 7-36, and 7-43, which are in area of former MA 28, but outside the present study area.

^bPercent of total kill in area of former M.A. 28 applicable to "inside" units.

^cPercent of total kill in area of former M.A. 28 applicable to "outside" units.

while there were 56 non-resident kills among 66 total in GMU's 7-31, 36 and 43. The majority (55) of reported kills during those years was from G.M.U. 43, and 48 of those were by non-residents.

Although Hunter Sample harvest figures for recent years are not in complete agreement with those for Compulsory Inspection (Table 12), it is nevertheless apparent with even the most extreme interpretation that the effect of hunting has been minimal in the study area since at least 1976.

2.9.2 Caribou habitat

Seasonal habitat use

Late winter (Vol. 2, Maps 9a, 10a, 13a): Caribou are most often seen on the windswept alpine tundra of the Rocky Mountain foothills (Churchill and Harper 1979). Terrestrial lichens, sedges, and other vascular plants are probably the main forage items. Caribou have also been in low-elevation muskeg forest and along lakeshores during late winter (Petro-Canada 1981), and Sopuck and Carruthers (1983) observed considerable use of low-elevation forest. In the Goodrich-Stephenson-Lehudette area, caribou are reported to use spruce - subalpine fir forests above 1200 m during winter (F. Harper, pers. comm.). According to Ministry of Environment, Resource Analysis Branch (1977) forage items in lowland muskegs and subalpine forests include arboreal lichens and shrubs.

In the Redrock Creek area of Alberta, about 40 km east of the British Columbia border, caribou winter in mature lodgepole pine stands and associated meadows (Bjorge 1982). Terrestrial lichens and vascular plants, obtained by cratering, are the preferred forage items, but arboreal lichens are also taken (R. Bjorge, pers. comm.).

Spring: There is little information from survey flights for this period. Caribou have been seen in the Sunderman Creek area more frequently during spring than other seasons (F. Harper, pers. comm.). Caribou studied by Sopuck and Carruthers (1983) moved from low-elevation conifer forests to the alpine during the period April-June.

Calving: Calving has been confirmed on the alpine slopes of several ranges including Bullmoose Mountain, Mount Spieker, Quintette Mountain, and the

mountains east of Mitska and Whatley creeks. Evidence of calving has not so far been observed in lowland habitats (B. Churchill, pers. comm.).

Summer: Most sightings are in the alpine. Some alpine winter ranges in the foothills are also used during summer. In addition, the rugged mountains along the western border of the subregion get summer use (Churchill and Harper 1979).

Rutting areas: Distribution of caribou sightings during this period suggests the following as possible rutting areas: Mount Minnes, the upper Narraway River drainage, Onion and Wapiti lakes, the plateau west of Quintette Mountain, the upper Wolverine River/Hook Lake area, Mount Spieker and Mount Reesor. Radio-collared caribou studied by Sopuck and Carruthers (1983) were in alpine and subalpine habitats during the rutting season.

Fall/early winter (Vol. 2, Maps 9a, 10a, 13a): Little information is available. At least some use of low-elevation pine flats occurs during this period: along Bullmoose Creek (B.C. Ministry of Environment, Resource Analysis Branch 1977), south of Tumbler Ridge, and on Kinuseo Creek (F. Harper, pers. comm.). In the Quintette Mountain area, most caribou were located in the alpine during this period, but some used low elevation conifer forests (Sopuck and Carruthers 1983).

Movement routes and special habitats: Movement occurs between caribou ranges in the Peace subregion and adjacent areas of Alberta. A bull caribou captured and radio-collared during winter 1981 on the Redrock Creek winter range (about 100 km SSW of Grand Prairie) summered in 1981 and 1982 in the Gorman Creek area of British Columbia. The animal's summer range was located about 55 km from his 1982 winter range in the Prairie Creek area (B. Wynes, letter to M. Vatamaniuck, 14 October 1982).

Movement patterns in the Quintette Mountain area are under investigation; results from the first year of study were reported by Sopuck and Carruthers (1983).

Factors affecting caribou habitat

Logging: In the study area, there has been less logging activity east than west of the Rocky Mountains. During the 1950's and 1960's, logging was carried out close to roads in the Pine and Sukunka drainages, and more extensively in the Redwillow area at the southern end of the Alberta Plateau. That intermediate utilization logging commonly left substantial amounts of residual timber. The cut-and-leave strip system was not used. In some cases, seed blocks were left. The total area harvested during that period was relatively small (L. Merkel, pers. comm.).

Most harvesting has been done since close utilization standards were introduced in 1966. Clearcut logging in the Tumbler Ridge area, Bullmoose Creek, Wolverine River, and Brazion and Hasler creeks has approached or impinged on caribou ranges. Forest harvesting in those areas has so far been limited to low elevations.

Silvicultural practices east of the Rocky Mountains are somewhat different from those west of the mountains, due to the drier, more windy climate. Spruce - subalpine fir stands are more likely to be thrifty mature and windfirm east of the Rockies. On medium sites, the usual prescription is to clearcut in 40-60 ha openings, windrow, and burn, in anticipation of natural regeneration. High sites are clearcut, windrowed, and burned or broadcast-burned, and planted with spruce. On the Alberta Plateau, where the distribution of spruce types is patchy and soils are poorly drained, extensive clearcutting in a one-pass system is recommended. Access is normally confined to winter roads. The large clearcuts are planted immediately with spruce (Revel and Fraser 1981).

Lodgepole pine types are clearcut, scarified, and allowed to regenerate naturally, as they are west of the Rockies (Revel and Fraser 1981).

In general, blowdown, bark beetles, and a backlog of overmature stands are not major problems east of the Rockies. The windy, dry climate makes fire control difficult, and can interfere with site preparation. Brush and grass competition are problems on the Alberta Plateau.

Transportation corridors and access: Mining and logging developments have created considerable access throughout the study area east of the Rockies. Logging road access is mainly limited to low elevations, but some mining roads

reach the alpine. The upper reaches of most watersheds along the Rocky Mountain crest are still without access. On the Alberta Plateau and other flatlands, access for all-terrain vehicles is enhanced by a network of seismic lines.

Access is expanding rapidly because of coal developments. Caribou ranges expected to be affected by increased access include the Narraway, Quintette, Wolverine, and Speiker-Reesor areas (Churchill and Harper 1979). The new Anzac-Tumbler Ridge rail line passes through suspected caribou habitat and may cause a collision hazard.

Fire history (Vol. 2, Maps 9c, 10b, 13b): An active fire history east of the Rocky Mountains has resulted in a patchy distribution of mature and immature spruce, lodgepole pine, and hardwood types (Revel and Fraser 1981). Large areas in or near caribou ranges that have burned in the last 40 years include Brazion Creek and North Burnt River, the upper Sukunka, Wolverine River and the south slope of Mount Reesor, Hook Lake, Calliou Lake, and Red Deer-Holtslander creeks. Since the role of mature forests in the ecology of caribou in this area is not clear, the impact of those fires on the animals is uncertain. Fire can be expected to affect caribou differently, depending on whether the primary winter forage items are arboreal or terrestrial lichens (Section 3.1).

Insect attack: Insect infestations are not a significant problem in the Peace TSA south of the Hart Highway at this time. Some small outbreaks of spruce beetle in the Tumbler Ridge area are being closely monitored by the Ministry of Forests (R. Cozens, pers. comm.).

Other developments and human activities: Present and planned development of the coal, petroleum, and mineral industries has the potential to affect caribou ranges throughout the study area east of the Rockies. Many caribou ranges in the Rocky Mountain foothills are directly underlain by coal reserves, and those that are not could be affected by access development (Environment and Land Use Sub-Committee 1977, 1978).

Churchill and Harper (1979) anticipated three major impacts from increased mining activity: 1) Road construction and mine development dividing the

habitat into smaller useable segments, as well as reducing the total amount of habitat available; 2) Linear developments such as roads, seismic lines and railroads creating barriers to caribou movements through snow accumulation patterns, and resulting in loss of access to critical habitats; and 3) Road access to previously inaccessible areas, especially alpine habitats, increasing legal and illegal hunting pressure, harrassment, and possibly even predation due to artificial accessibility to predators. Added to these potential impacts might be the risk of mortality from collision with vehicles and trains, especially during winter when ploughing creates berms.

Status of habitat in caribou ranges

The few low-elevation winter ranges that have been identified in this subregion are located on the Alberta Plateau, east of the high-elevation ranges (Fig. 11). They are composed mainly of non-productive forest, lodgepole pine, and immature timber. The high-elevation winter ranges, like those in the Omineca subregion, are made up of varying proportions of spruce-balsam, alpine forest, and alpine. Unlike high-elevation ranges in the Omineca subregion, those in the Peace also have substantial components of immature timber (5-29%) and lodgepole pine (3-15%), reflecting the active fire history east of the Rocky Mountains.

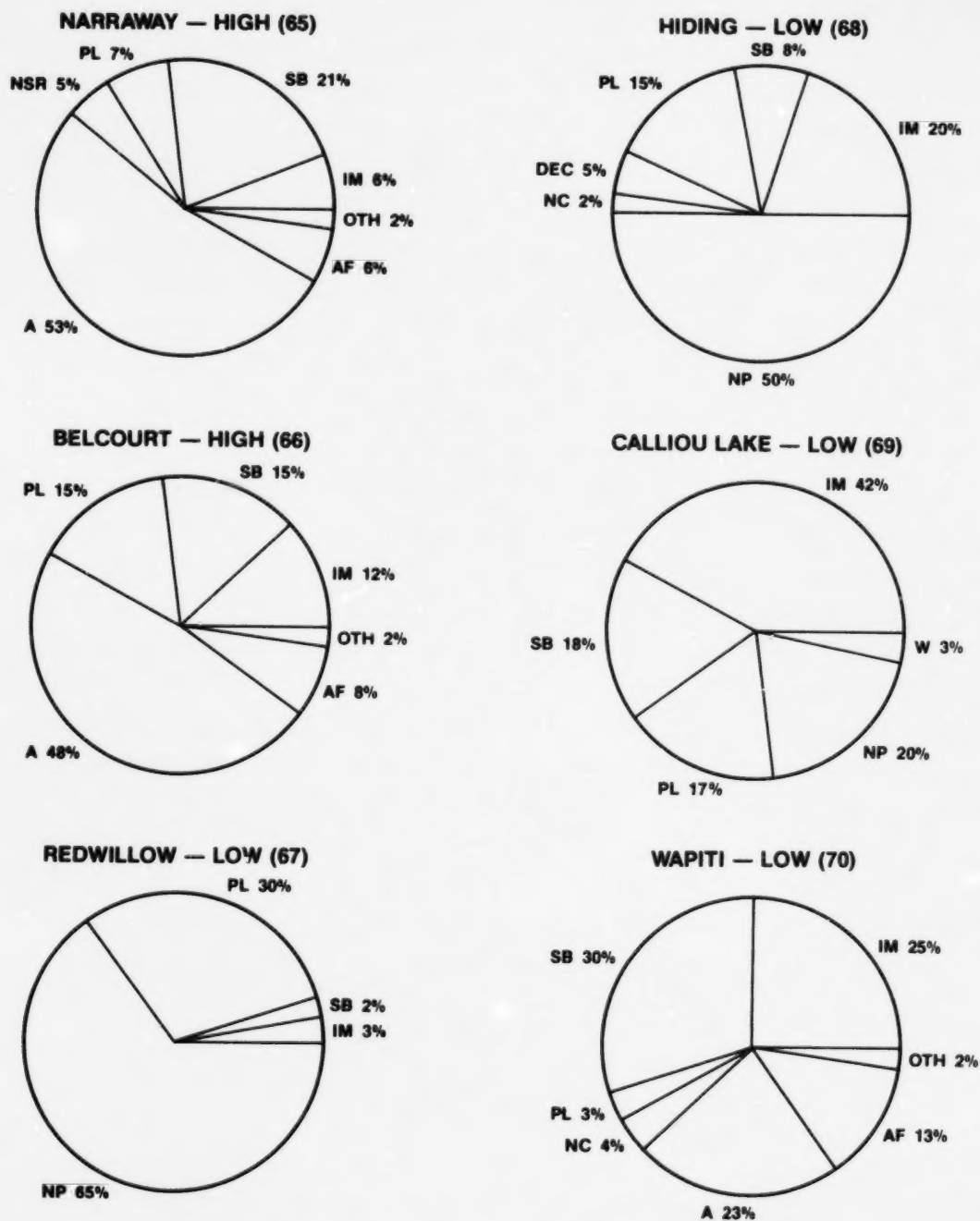
According to our information, logging has taken place only within the Bullmoose Creek Flats winter range. Logging is present adjacent to the Goodrich-Stephenson-Lehudette, Spieker-Reesor, Bullmoose-Chamberlain, and Sukunka ranges.

Forest management planning

Caribou ranges east of the Rocky Mountain crest and south of the Hart Highway are located in the Peace Timber Supply Area. The Yield Analysis Report for the Peace TSA (Prince George Forest Region 1981) projected that after 60 years, the timber supply would fall below the commitment level of 1 585 860 m³/yr that existed at that time.

In contrast, the most recent analysis of the timber supply (B.C. Ministry of Forests 1983) indicates that the present AAC of 2 000 000 m³ can be maintained throughout the 200-year look-ahead period. The main difference between those two analyses is a differing set of assumptions about future land

**FIGURE 11. Status of habitat in caribou ranges:
Region 7-Peace.**

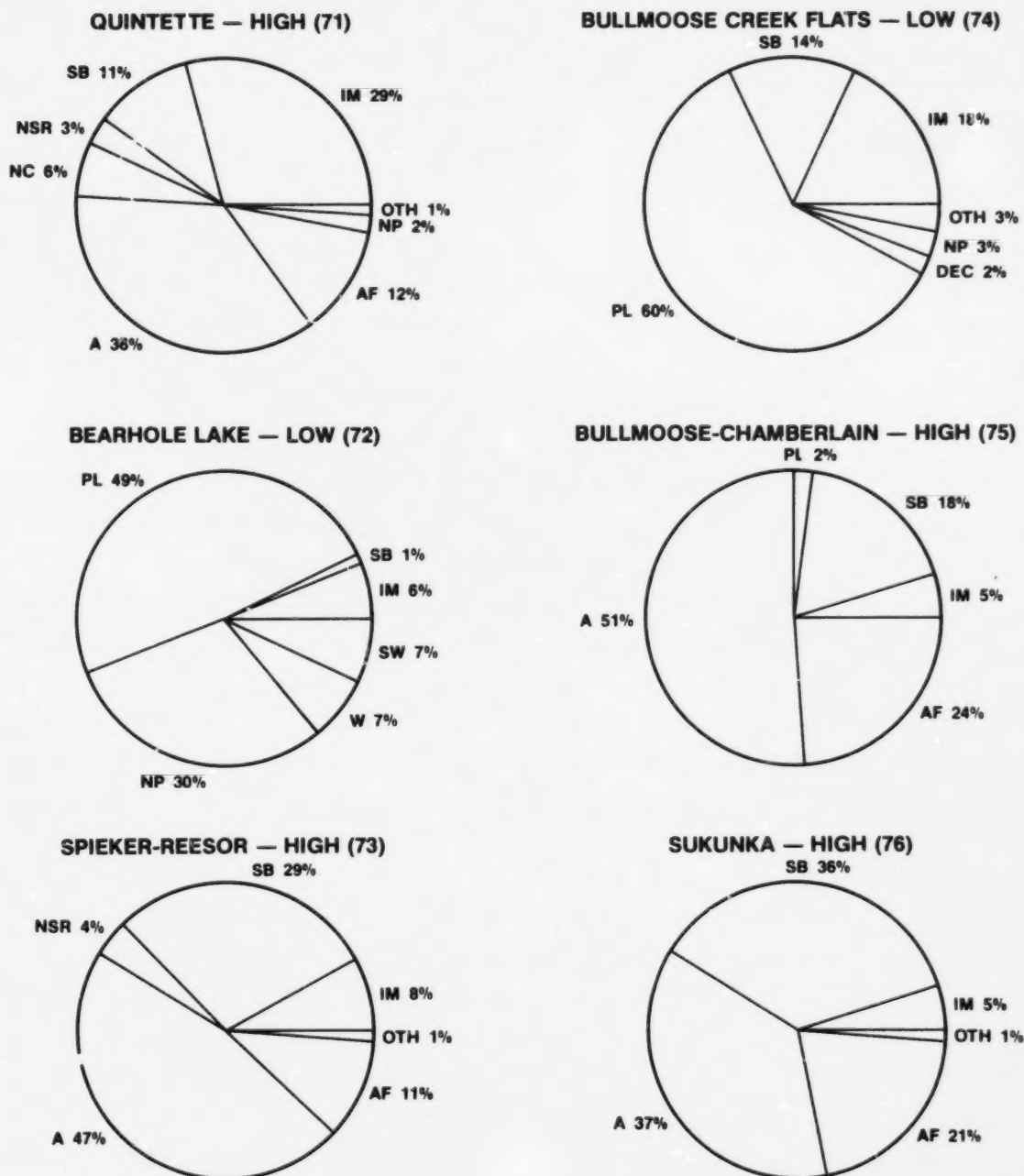


LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

**FIGURE 11. Status of habitat in caribou ranges:
Region 7—Peace (continued).**

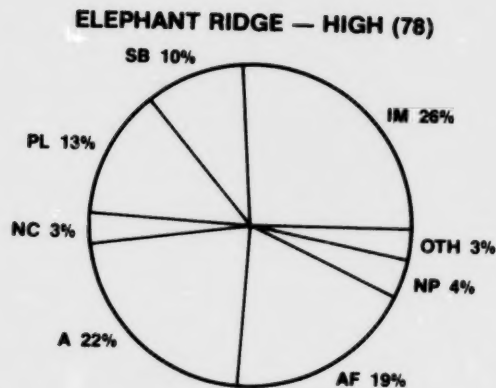
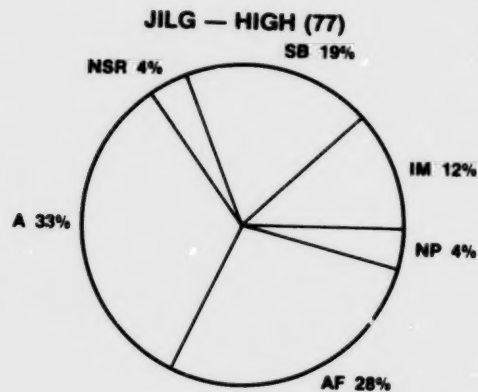


LEGEND

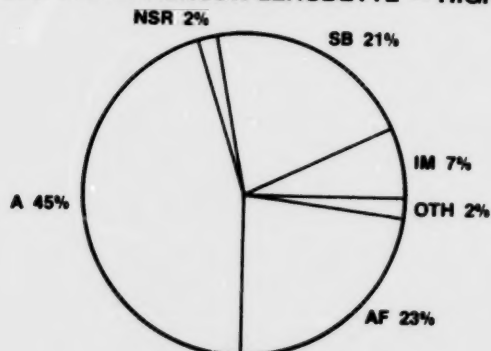
IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

**FIGURE 11. Status of habitat in caribou ranges:
Region 7-Peace (continued).**



GOODRICH-STEPHENSON-LEHUDETTE — HIGH (79)



LEGEND

IM	Immature	NC	Non-commercial timber
CH	Mature cedar-hemlock	DSD	Disturbed, stocking doubtful
SB	Mature spruce-balsam	A	Alpine
PL	Mature lodgepole pine	AF	Alpine forest
FIR	Mature Douglas-fir	NP	Non-productive forest
PW	Mature white or white-barked pine	SW	Swamp
DEC	Mature deciduous	W	Water
RES	Residual	OR	Open range
NSR	Not sufficiently restocked	ROC	Rock
		OTH	Other

Categories with less than 1% are grouped into OTH

alienations (D. Robb, pers. comm.). According to the AAC Determination for the Peace TSA (29 May 1981), the Ministry of Forests can maintain the harvest level, but future growth in other resource uses could result in losses to forest land that would eventually cause the AAC to be reduced.

Habitat protection

Habitat protection efforts for caribou have responded primarily to mining exploration and development. Since access is expected to have the greatest impact on caribou, habitat protection staff have tried to keep roads away from known caribou ranges. Roads and other surface disturbances in the alpine are discouraged. Exploration in calving areas is restricted until after July (F. Harper, pers. comm.).

The major impact of forestry on caribou in the subregion is thought to be the development of road access. Spruce - subalpine fir stands above 1200 m are considered sensitive areas for caribou, but the Fish & Wildlife has not been approached on logging at that elevation. Habitat Protection staff feel that the role of forests in the ecology of caribou in their subregion is not well enough known that they can identify conflicts with forestry, if they exist. The main areas of concern with respect to forest development are the Goodrich-Lehudette-Stephenson and Jilg caribou ranges (F. Harper, pers. comm.).

2.9.3 Information needs

Although considerable work has been done on identifying caribou ranges in this subregion, the animals' basic biology is poorly understood. Because wildlife managers do not know what, if any, of their habitat requirements are met by forests, they do not know what habitat protection measures are required. Differences in climate, topography and vegetation make it difficult to extrapolate from better-known areas west of the Rocky Mountains. Studies by the Alberta Fish and Wildlife Division based in Grande Prairie and Edson probably provide a better basis for extrapolation.

Because of the extensive mining development in the subregion, the need is acute for better information on the response of caribou to access development and industrial activity.

2.9.4 Information base (see also Appendix 3)

Aerial surveys

CLI, RAB, TSB

93I: 1/24-28/69, 6/7,8,23/76, 7/30/76, 8/10/76,
10/19-20/76, 11/16,30/76, 12/14,18-19/76,
1/21-22,25-26/77, 2/1-3,17-19/77, 3/7,9-10/77,
5/24/77, 9/18-20/77, 10/2-3/77, 12/11-13/77,
1/13-19/78, 3/11/82

930: 1&2/66, 3/6-8/74, 3/11/82

93P: 3/24,25,28/66, 6/7,8,23/76, 7/30/76, 8/10,27/76,
10/19,20/76, 11/16,30/76, 12/1,14,16,18-20/76,
1/9,21-22,24-26/77, 2/1-3,17-18/77, 3/7-10/77,
5/24/77, 10/2-3/77, 12/11-13/77

Resource Analysis Branch, Northeast Coal Studies 1976-78

Major activities: Aerial surveys, ground inspection, interviews,
biophysical capability mapping, identification of wildlife
habitat associations, impact assessment.

Reports: B.C. Ministry of Environment, Resource Analysis Branch
(1977, 1979); Environment and Land Use Sub-Committee
(1977, 1978).

Other Northeast Coal reports

Churchill and Harper (1979) - Identifies critical caribou
ranges, provides estimates of existing and potential
populations, describes potential impacts of coal development.

Petro-Canada (1981) - Briefly reports caribou observations and
identifies ranges in the Quintette Mountains.

Guide-outfitter interviews, Fish and Wildlife Branch summer
student project 1973-74.

Major activities: Interviewing guides, mapping caribou ranges as
reported by guides.

Incidental sightings - A few. Most caribou observations based on Northeast Coal Study flights.

Caribou research in adjacent Alberta

Alberta Fish and Wildlife Division studies of caribou in the Redrock creek area, Alberta 1980 to present.

Major activities: Radiotelemetry, ground surveys, fecal fragment analysis, habitat studies.

Reports: Bjorge (1982).

2.10 Summary

2.10.1 Caribou populations

Distribution

The distribution of caribou in the study area is shown in Fig. 1. The distribution we observed is only slightly different from that mapped by B.C. Ministry of Environment, Fish and Wildlife Branch (1979a).

Evidence for changes in distribution comes from historic reports of caribou occurrences and records of shed antlers in locations where no caribou have been observed recently. A few observations of caribou in new locations also occurred. It is difficult to make inferences about distributional changes from those kinds of data. Changes in the pattern of observations may represent normal wanderings, local changes in numbers, shifts in the distribution of caribou, or shifts in the distribution of observers. Those cautions notwithstanding, it is evident that some ranges have been abandoned in every region studied, and the overall distribution of caribou in the study area has diminished in historic times.

Numbers, status and management

Table 13 summarizes the primary data relating to caribou numbers and management in the study area. Based on data available at the time, Bergerud (1978) calculated a total of about 2100 animals for that area, or about 20% of his estimated provincial total of 10 500. Since his study, managers have revised some previous estimates, mostly subjectively, such that numbers in Region 3 are believed to be substantially less (40%) than in the mid-1970's, those in Region 4 and in the Northeast Coal area of Region 7 are somewhat

TABLE 13. Summary of population and harvest information in the present study area

Area ^a	Pop. estimates ^b		Data source ^c	Hunting opportunity ^d		Annual harvests ^e		Apparent population trend ^f
	Bergerud	Current		No. G.U.'s	No. Open	Mean	Range	
Region 3 and 8	515	300 ¹	4	12	2	0.4	0-1	I
Region 4	500	415 ²	1	36	4	1.0	0-2	D
Region 5								
Queensland Highland	200	235 ²	2	4	1	3.4	0-7	D
S. Tweedsmuir	279	711 ³	3	4	1	19.8	9-28	I*
Region 6								
Tellico	40	71 ³	3	1	0	0	0	I
N. Tweedsmuir	75	368 ³	3	4	29	1.0	0-3	I*
Region 7								
Oadineca	200	500 ^{1,2}	1	14	0	0	0	D
Northeast Coal	300	260 ²	2	4	3	1.8	0-5	
Total Study Area	2109	2860	-	79	13	27.4	20-39	-

^aMajor "herd" units as discussed in text.

^bBergerud (1978, Table 29); Current - new figures since Bergerud: 1 = rough estimates implied by summary statements in text; 2 = most recent estimates by regional managers, as quoted in text; 3 = largest recent single count, i.e. documented minimum population.

^cSubjective scale of population survey effort: 1-5, where 1 = incidental observations only and 5 = regular systematic census activity.

^dOpportunity - number of game management units in each area, and those with an open season for caribou in 1982.

^eCompulsory Inspection data for the 5-year period, 1978-1982.

^fTrend (I=increasing, D=decreasing, S=stable) inferred from information available (see text). Those with an asterisk are more certain than the others.

^gOnly non-park portions open to hunting, and that by limited entry draw only.

lower (15-20%) and that in the Quesnel Highlands is about 17% higher. Numbers in three other areas (the Telkwa Range and North and South Tweedsmuir) have been demonstrated to be much higher than previously thought by virtue of recent single counts which greatly exceeded Bergerud's population estimates. The March 1984 count in the Cariboo Mountains has shown that his estimate of 200 for the "Yellowhead" herds (Omineca, Region 7) was also far too low and we have generated a new minimum estimate of 500 accordingly.

The total of the current estimates, 2860, is 36% higher than that produced by Bergerud (1978), and might still be low since the four high counts mentioned above probably did not represent population totals. However, an opposing bias is potentially present, in that some estimates may be inflated by duplicate sightings (animals seen in more than one place and therefore counted more than once). Census inconsistencies and inadequacies constitute a major feature of the available population information for the study area.

Over most of the area of interest, caribou numbers are believed to have declined significantly in the 1930's, remained low in the 1940's, then increased in the 1950's to peaks in the 1960's, after which they again declined. Region 4 and much of the Quesnel Highland area may have departed from that pattern in that neither are known to have recovered appreciably after the decreases in the 1930's. The patterns indicated here, and most of those through the 1960's, are based on subjective recollections and not on comparative counts. Attempts at census have been more common in the study area since the early 1970's, although some areas have not been surveyed at all (Region 4; parts of Region 7) and most of the others have provided data only through partial or irregularly scheduled surveys. The result is that recent trends in the various areas are difficult to ascertain. As listed in Table 13, two of the eight areas listed appear to be supporting increasing populations, two others may be increasing, three may be decreasing and the last has been monitored too little to enable a determination.

Just over 50% of the animals in the current estimate (1450) are of the mountain ecotype. The rest are of the northern ecotype, which also occurs in the remaining British Columbia caribou ranges, outside of the present study area.

During the mid- to late 1960's, very liberal hunting seasons, open to both sexes, were in effect over most of the area, and some very large harvests

appear to have occurred during that period. It is generally believed that overhunting caused or contributed to the post-peak declines in several areas, especially the Telkwa, north Tweedsmuir, and Omineca areas. However, official harvest data are not conclusive. The trend since the establishment of GMU's in 1975 has been for increasing restrictions, including shortened seasons and removal of either sex opportunities, in the few units which have remained open. As shown in Table 13, only 13 (16%) of the 79 GMU's in the study area had open seasons for caribou in 1982, and harvests there have averaged only about 27 animals per year (1% of the estimated population) over the past five years. Nearly 85% of the study area kill has been in Region 5, mostly from the Itchas-Ilgachuz area.

2.10.2 Caribou habitat

Seasonal habitat use

Patterns of winter range use reflect differences in forage availability, which in turn reflect differences in climate and topography. Mountain caribou ranges in Regions 3, 8, 4, and portions of 5 and 7 are within the high-snowfall region where arboreal lichens predominate in the winter diet (Fig. 1). In the northern caribou ranges of Region 6 and parts of 5 and 7, terrestrial vegetation is available in winter.

Two broad patterns of winter habitat use occur among mountain caribou. The animals use low- and mid-elevation forested habitats where they feed on vascular plants and on arboreal lichens available as litterfall, on windthrown trees, or on felled trees. The soft snow conditions that favour that pattern of habitat use are common during early winter, although they may also occur later in the season. Caribou have been observed in mature cedar - hemlock, cedar - hemlock - spruce, and lodgepole pine types under those conditions, but little is known of the basis for habitat selection.

When the snowpack is settled at high elevations, mountain caribou are usually found in open Engelmann spruce - subalpine fir forests, where they feed on arboreal lichens. This pattern of range use is common in late winter. It may be interrupted by movements to lower elevations during periods of soft snow or by movements from one subalpine range to another for no apparent reason. Although this general pattern of habitat use occurs from the Macgregor Plateau to the United States border, there are variations and

exceptions; at any one time, caribou may be found at high and at low elevations within the same local area.

Late in the winter season, terrestrial vegetation is sometimes available on exposed alpine slopes before the snow recedes elsewhere. That forage source is used by mountain caribou.

For northern caribou, there is little differentiation between early winter and late winter ranges. The snowpack ordinarily allows access to terrestrial vegetation -- grasses and sedges, low shrubs, and lichen. Northern caribou use windswept alpine slopes, muskegs, and lodgepole pine forests. Snow characteristics likely affect habitat selection differently there than they do in the high-snowfall zone. The importance of arboreal lichens, and the habitats that provide them, is unclear.

In spring, mountain caribou generally move downslope and use areas where green vegetation is available. Use of low-elevation mature timber, low-elevation clearcuts, slides, and riparian sites has been reported. Spring habitats of northern caribou are almost unknown, although a downslope movement has been noted in Region 6.

Calving areas of northern caribou are better known than are those of mountain caribou. Northern caribou regularly use calving areas on exposed alpine ridges and plateaus. In the northern Tweedsmuir area, there is evidence suggesting that islands and low elevation forests are sometimes used for calving. If other habitats are also used, they have not been identified. Until recently, calving habitat of mountain caribou was unknown, although there were unconfirmed reports of a variety of calving habitats. Now, use of a barren alpine slope has been observed in Region 7, whereas radiotelemetry data from Region 4 point toward use of steep, timberline forests. More information is needed about the variety of habitats that are used for calving. The importance of tradition in the selection of calving sites by individual animals is also unknown.

Throughout the study area caribou use high-elevation habitats during summer. Moist alpine and subalpine meadows provide an abundance of forbs, grasses, and sedges. Snow patches are used during late summer, presumably to relieve heat stress, insect harassment, or both. There is also some use of timbered habitats -- mostly subalpine forests, but sometimes valley bottoms. Forested habitats may function as thermal and insect cover during summer,

especially when snow patches are absent. Radiotelemetry data from the Kootenays indicate that some animals remain low throughout the summer. It is unclear whether the scattered summer observations of caribou at low elevations, which occur throughout the study area, mainly represent extended use of low-elevation ranges or movements from one high-elevation range to another.

Rutting areas are poorly known. Because of the lack of repeated observations, we do not know to what extent specific rutting areas are traditional. Rutting has been reported in a variety of habitats: alpine plateaus, timberline meadows, subalpine forests, pine flats, and valley bottoms. The habitat characteristics caribou select for rutting areas are unknown.

Movement routes and special habitats: Although a number of movement routes have been mapped (Vol. 2, Caribou Range Maps), those maps represent a very limited understanding of the movement patterns of caribou in the study area. In many areas, only a few sites, where caribou regularly cross highways or logging roads, have been identified. Most longer movement routes have been mapped on the basis of anecdotal reports from local residents. However, recent radiotelemetry studies are helping to elucidate the nature of movements by caribou.

Radiotelemetry studies of mountain caribou confirm, in a general sense, the pattern of altitudinal migration described by Edwards and Ritcey (1959): the use of high-elevation habitats in summer and late winter, and lower elevation habitats in early winter and spring. However, movements are proving to be more complex and extensive than originally thought. Within-season altitudinal movements also occur; some of those can be understood as responses to changing snow and weather conditions. Altitudinal movements also occur among northern caribou, but they do not follow the same pattern.

Horizontal seasonal movements also occur. Some summer ranges are higher and more rugged than winter ranges, or are located in areas of higher snowfall. A straight line distance of 153 km has been recorded between an animal's summer range in British Columbia and its winter range in adjacent Alberta (J. Edmonds, pers. comm.). Within-season horizontal movements also

occur; animals may move from one seasonal range to another similar one for no apparent reason.

The importance of tradition in maintaining movement routes in the study area is unclear. Although some movement routes have been affected by habitat changes and by the creation of potential barriers, the responses of caribou to those alterations have not been specifically studied.

Like other ungulates, caribou use mineral licks. Some of those have been mapped. Their functional importance to the animals is not known.

Factors affecting caribou habitat

Logging: In general, logging has a longer history in mountainous southeastern British Columbia than in the northern and western portions of the study area. From the crest of the Rocky Mountains south to the United States border, logging practices followed a broadly similar pattern. The earliest logging involved selective removal of high-quality stems of cedar, Douglas-fir, and spruce, leaving hemlock, subalpine fir, and poor-quality cedar. Prior to 1966, a variety of partial cut systems was used: diameter limit logging, single tree selection (marked to cut), clearcutting with seed blocks, and cut-and-leave strips. All clearcut logging was done to intermediate utilization standards; that is, trees greater than 11.1 in (28.2 cm) in diameter at breast height were used.

All those logging systems left considerable amounts of residual timber. However, the residual stands were susceptible to windthrow, and many older cutblocks have since been blown down, salvage logged, or clearcut. Most pre-1966 logging was located in valley bottoms and near roads; much of it was peripheral to caribou ranges. For those reasons, the area within caribou ranges occupied by residual stands from partial cut or intermediate utilization systems is relatively small.

In 1966, close utilization standards were introduced provincially. Most logging in the study area since that time has been patch clearcutting to those standards; trees greater than 7.1 in (18.0 cm) in diameter at breast height are used. Clearcutting is done in patches, leaving mature timber between patches for later harvests. The patch sizes that are considered optimum vary from one region to another, but are regularly exceeded, especially where insect attacks are epidemic. In parts of the Kamloops and Nelson regions,

diameter-limit logging is used in some caribou ranges in an effort to preserve a lichen-bearing stand. Overall, where logging has occurred in caribou habitat in southeastern British Columbia, clearcuts with little or no residual timber predominate.

The usual silvicultural prescription in southwestern British Columbia is to clearcut, broadcast burn or windrow and burn, and plant spruce. Variations occur. Lodgepole pine stands are clearcut, may or may not be scarified, and are left to regenerate naturally. In some instances, a healthy stand of subalpine fir advanced regeneration is protected for silvicultural reasons. Burning is not recommended on some sites. Douglas-fir and lodgepole pine are sometimes planted. In practice, silvicultural prescriptions are not always realized -- a backlog of untreated, unplanted cutblocks exists in many areas.

Stand tending is not yet common in caribou ranges in the southeastern mountains, although some juvenile spacing of subalpine fir and lodgepole pine is done.

In the western portion of the study area, and north of the crest of the Rocky Mountains, little logging occurred in caribou ranges until after the introduction of close utilization standards. Clearcutting is the only logging system used since that time. As in the southeastern mountains, the most common silvicultural prescription in spruce-subalpine fir types is to broadcast burn or windrow and burn after clearcutting, and to plant spruce. Lodgepole pine types -- which are extensive in those areas -- are clearcut, may or may not be scarified, and are left to regenerate naturally. Overstocking is expected to be a problem in the naturally regenerated stands, and juvenile spacing is planned.

Transportation corridors and access: Some access to caribou ranges in all regions is provided by highways, mining roads, and networks of logging roads. Seismic lines contribute to access on the Alberta Plateau and east of the Itcha Mountains. Road development has been related to increased hunting mortality in the Kootenays, and harassment in the Telkwa Range. Wildlife managers have the authority under the Wildlife Act to restrict the use of motorized vehicles for the purpose of hunting. However, we are aware of only one successful attempt to restrict road access for any purpose in caribou

ranges: Carolina Creek Road in the southern Selkirks was closed under the Forest Act.

Roads, especially highways, are also a cause of mortality from collisions with vehicles. We are aware of documented instances of collision mortality along Highway 3 between Salmo and Creston, and Highway 10 between Prince George and Valemount. Hazards to caribou also exist along Highways 23 and 31 in the central Selkirks, Highway 1 between Revelstoke and Golden, Highway 23 north of Revelstoke, and Highway 5 between Lempriere and Blue River. Collisions undoubtedly occur along logging and mining roads as well, but they rarely come to the attention of officials or researchers.

Caribou ranges are traversed by the Canadian Pacific Railway, the Canadian National Railway, and the new Anzac-Tumbler Ridge railway. The loss of at least 17 caribou through railway collisions on a single day (Section 2.8.2), indicates the potential importance of that mortality factor.

Despite the extensive development of access in the study area, a number of small areas and several large ones remain inaccessible. The following areas have little or no road development, except as noted:

- Tweedsmuir Park and the Itcha and Ilgachuz ranges (except for a road along the Dean River);
- the crest of the Rocky Mountains and the upper parts of most drainages from Pine Pass to the Willmore Wilderness Area;
- the Kinbasket Lake area east to the Rocky Mountain park system (except at the north end of the lake);
- Wells Gray Park and adjacent areas to the northwest: the area between the north and west arms of Quesnel Lake, Bowron Lake Park, and the upper watersheds of the Cariboo mountains as far northwest as Haggan Creek;
- much of the northern Purcell and Selkirk ranges (except for Highways 1 and 23).

The importance of parks in maintaining roadless areas in this province is evident.

Fire history: Scattered fires have occurred throughout the range of mountain caribou, but some areas have been affected more than others. In the southern Selkirk and Purcell mountains, large areas are in early seral stages

because of fire. Fires that occurred along the Canadian Pacific Railway corridor in the late 19th century resulted in stands that are still too young to support abundant lichen forage. Large areas in Wells Gray Park and elsewhere in the Kamloops Forest Region burned in the 1920's and 1930's, and smaller areas have burned more recently. The southern portion of the Quesnel Highland and parts of the Prince George Forest Region have been affected by scattered large fires, most of which occurred during the 1960's. Fires in mountain caribou range have a negative impact on habitat value (Section 3.1).

In most ranges inhabited by northern caribou, fire frequency has been high historically, as indicated by extensive stands of even-aged lodgepole pine. To the extent that those animals depend on terrestrial rather than arboreal forage, fires probably have an overall beneficial impact on caribou habitat, providing that alternative ranges are available during early successional stages.

Insect attack: Spruce beetle and mountain pine beetle are epidemic in caribou ranges in parts of the study area. Spruce beetle infestations are particularly likely to coincide with caribou ranges, because of the insect's preference for mature and overmature spruce stands. Severe spruce beetle infestations are occurring in the Prince Rupert, Prince George, and Cariboo Forest Regions, where the pest is a major factor influencing forest management decisions. The caribou ranges in these regions that are most affected by spruce beetle attack and associated logging activities are the area east of northern Tweedsmuir Park, the Bowron River watershed and adjacent drainages, the upper Macgregor drainage, and parts of the Quesnel Highland. Spruce beetle attacks are less extensive in the Kamloops and Nelson Forest Regions, but several of the areas that have been attacked are caribou ranges: Miledge Creek, Pingston Creek, and the southern Selkirk Mountains.

Mountain pine beetle epidemics are also presenting serious forest management problems in the study area, but they are generally peripheral to caribou ranges. A severe mountain pine beetle epidemic in the Chilcotin is presently concentrated to the south of caribou ranges. Infestations are also present in the Telkwa Range, Tweedsmuir Park, the Quesnel Highland, and the Kinbasket Lake area, but their impact on caribou range is not great.

Insect infestations affect caribou primarily by leading to intensified forest harvesting. The effects on caribou of insect-induced changes in the forest structure may be either positive or negative, but are minor compared to the effects of logging.

Other developments and human activities: Caribou in the study area have been affected by several hydroelectric developments: the Kenney, Mica, Duncan, and Hugh Keenleyside dams. The effects of reservoirs on caribou are not well documented, but probably include mortality from drowning, flooded habitat, and blocked movement routes. Ongoing studies by K. Simpson in the Revelstoke Dam area may help to clarify the effects of hydroelectric development on caribou.

Prospecting and mining are ubiquitous in the study area, and have affected caribou by introducing roads and human activity into remote areas. The Northeast Coal development is the only mining project in the study area that is expected to have a major, concentrated impact on caribou. Seismic lines are present in caribou habitat east of the Itcha Flats, and in the Alberta Plateau and Foothills.

Recreational activities -- hiking, snowmobiling, cross-country skiing, heli-skiing -- occur in caribou ranges and are believed to cause harassment in some areas. In several cases, local snowmobile associations have agreed to restrict their activities to certain areas, to avoid disturbance of caribou on their winter ranges. We are aware of no cases outside parks in which snowmachine use has been formally prohibited for the protection of caribou, although there are cases in which the use of snowmachines for hunting is restricted.

Status of habitat in caribou ranges

The Mark IV data base of the Ministry of Forests Inventory Branch, in conjunction with maps prepared from Landsat imagery, were used to describe the status of habitat in those caribou winter ranges that we identified. Low- and high-elevation winter ranges were distinguished. In general, high-elevation winter ranges are better known than low-elevation ranges, and were probably mapped more accurately.

High-elevation winter ranges in the range of mountain caribou are composed primarily of spruce - balsam stands, alpine forest, and alpine areas, in proportions which vary according to topography. Low-elevation winter ranges in that area are composed of cedar - hemlock and spruce - balsam stands, sometimes with lodgepole pine or Douglas-fir. Proportions of immature or understocked types (IM, NSR, DSD) vary according to fire and logging history of the area, but are typically much greater in low- than in high-elevation ranges. Some logging has occurred in nearly all low-elevation ranges and many high-elevation ranges in the range of mountain caribou.

In the western portion of the study area, in the range of the northern caribou ecotype, most high-elevation winter ranges have a relatively large alpine component. Low-elevation ranges are mostly mature and immature lodgepole pine. East of the Rocky Mountains, high-elevation ranges are composed mainly of spruce - balsam, alpine forest, and alpine. Low-elevation ranges are composed of non-productive forest and mature and immature lodgepole pine. Low- and high-elevation ranges east of the Rocky Mountains have a large immature component, which has resulted mainly from an active fire history rather than from forest harvesting. Most of the winter ranges of northern caribou have so far sustained little impact from logging.

Forest management planning

Throughout the province, some degree of falldown in the timber supply is projected. Within the study area, many of the TSAs that support caribou populations face special short-term supply problems, long-term supply problems, or both. Short-term supply problems are being experienced in the following TSA's: Okanagan, Lakes, Cranbrook, and Arrow. The most serious long-term supply problems (80 years or less to falldown, or falldown 15% or more) occur in the following TSA's: Okanagan, Peace, Lakes, Morice, Kootenay Lake, Arrow, and Golden. In any given caribou range, the pressure to harvest timber depends on a complex of local factors, as well as on the overall timber supply situation in the TSA. We attempted to identify these where we could.

Habitat protection

Within the range of mountain caribou, the main concern of habitat protection staff has been the retention of mature timber in wintering areas.

In Fish and Wildlife Regions 4, 8, and the eastern portion of 3, habitat protection measures have included modifications to the size and location of cutblocks, small reserves to protect movement routes or other key areas, and selective logging. Selective logging techniques, which are generally practised only in critical areas, have included site-specific diameter-limit cuts, faller's judgment, and a combination of the two. By opening closed-canopy forests through selective logging, managers hope to improve lichen production on residual trees.

In the southern Selkirks, habitat protection concerns have led to the removal of 26 928 m³ from the Allowable Annual Cut of the Kootenay Lake TSA. In the protected area, a cut/leave ratio of 20/80 is applied, rather than the usual ratio of 40/60, except where salvage logging of beetle-infested stands is taking place.

In the western portion of Region 3 and the eastern portion of Region 5, the Fish and Wildlife Branch and the Ministry of Forests have been unable to reach an agreement on habitat protection policy for caribou ranges. In that area, winter range for caribou is dominated by high-elevation plateaus forested with semi-open stands that are not thought to benefit from selective cutting. The area that Fish and Wildlife staff have attempted to reserve from logging is considered too large by regional Ministry of Forests personnel. The resolution of this conflict awaits an ELUC decision on old-growth timber in the Quesnel-Shuswap Highlands. In the meantime, decisions on logging in caribou ranges are handled by referral. Ten thousand hectares of caribou habitat adjacent to Wells Gray Park have been deducted from the Allowable Annual Cut of the Kamloops TSA.

In Region 7 (Omineca subregion), logging in high-elevation caribou ranges is less common than it is further south. Habitat protection policies in caribou ranges are to maintain corridors of mature timber across valleys, and to limit cutblocks to 80 ha or less. Much of the logging in the area is currently directed toward areas of spruce beetle attack, where habitat protection policies are not generally applied.

Within the range of northern caribou, habitat protection staff are frustrated by lack of information on the role of forests in the ecology of caribou; they do not know what, if any, habitat protection policies are appropriate. In Region 6 east of Tweedsmuir Park, reserve corridors were

established to protect suspected migration routes and wintering areas; corridor locations were later altered because of spruce beetle attacks. Elsewhere, habitat protection policies have not been established, either because logging is still peripheral to caribou ranges, or because conflicts with logging have not been identified.

In Region 7 (Peace subregion), mining exploration and development is the major habitat protection problem. Habitat protection staff have attempted to keep roads away from caribou habitat, to discourage surface disturbances in the alpine, and to restrict human activity in calving areas during calving season.

2.10.3 Information needs

Most research on caribou in the study area has focussed on mountain caribou, and some aspects of general biology, such as seasonal habitat use and food habits, are better known for those animals than for northern caribou. Many high-elevation ranges, especially winter ranges, of mountain caribou have been identified, and something is known of resource use on high-elevation ranges. There is a need for identification of low-elevation winter ranges, and for information on resource use on low-elevation ranges. Habitat requirements for rutting and calving areas, and their specific locations are poorly known.

The most urgent information need of biologists who manage northern caribou concerns the role of forests in the ecology of the animals. Because managers are uncertain which forested ranges are used, or what forest resources are important, they are uncertain what, if any, habitat protection policies should be instituted. As mining exploration and development is taking place in the range of northern caribou, managers also recognize a need for information on the effects of access and human activities on caribou.

Biologists in all regions need information on home range sizes, movement patterns, and the geographical extent of the populations they manage. That information is especially needed for the animals that frequent the two large provincial parks that support caribou: Wells Gray Park and Tweedsmuir Park.

Managers also need more accurate figures on numbers and composition in all of the various populations concerned. Thus they first need reliable census methods and, because of the probable inter-regional distribution of some

populations, a co-ordinated and consistent plan for employing them. Finally, there is a general need for more detailed information on natural mortality and features of natality as they relate to harvest strategies. Most published data on population dynamics of the species are from ecotypes much farther north. A more detailed discussion of information needs is given in Chapter 6.

3 FOREST MANAGEMENT AND CARIBOU

Managers seek forestry practices that will allow them to extract timber from caribou ranges while maintaining caribou populations. Timber harvesting potentially affects caribou in two ways: it creates access to caribou ranges, and it alters the structure of the forest. In this section, we review the functional relationships between caribou and forests, discuss the effects of logging on those relationships, and examine a number of forestry practices that are in use or have been proposed for caribou habitat.

3.1 Relationships Between Caribou and Forests

In their model of the effects of forestry practices on wildlife, Bunnell and Eastman (1976) identified six basic resources -- energy, nutrients, water, temporary shelter, habitation (dens and cavities), and escape cover -- as essential to wildlife. Of those six, energy and nutrients packaged together as forage, temporary shelter from abiotic elements, and escape cover are the forest resources considered most important to caribou.

Caribou use three major forage types in forests -- arboreal lichens, terrestrial lichens, and vascular plants. The relative availability of the forage types depends on their absolute abundance, and on snow conditions. Changes in snow depth or density may cause caribou to switch between arboreal and terrestrial forage; however, there are broad geographic areas in which one forage type predominates in the winter diet.

In the eastern portion of the study area, from the Rocky Mountains west, mountain caribou feed primarily on arboreal lichens during winter (Fig. 1) (Bergerud 1978). In the ICH and lower ESSF zones, which caribou exploit especially during periods of soft snow, the animals eat arboreal lichens that are available as litterfall and on fallen trees (Edwards and Ritcey 1960; Freddy 1974a; Bloomfield 1980b; T. Antifeau, unpubl. data; K. Simpson, unpubl. data). Caribou also forage on arboreal lichens in areas of active logging, even under soft snow conditions, by using skidroads for travel and by yarding around felled trees (T. Antifeau, pers. comm.). At low elevations, lichens are not usually abundant on the lower branches of trees. But in the upper Engelmann Spruce - Subalpine Fir Zone, where the canopy is more open, arboreal lichens are usually abundant in the lower as well as the upper

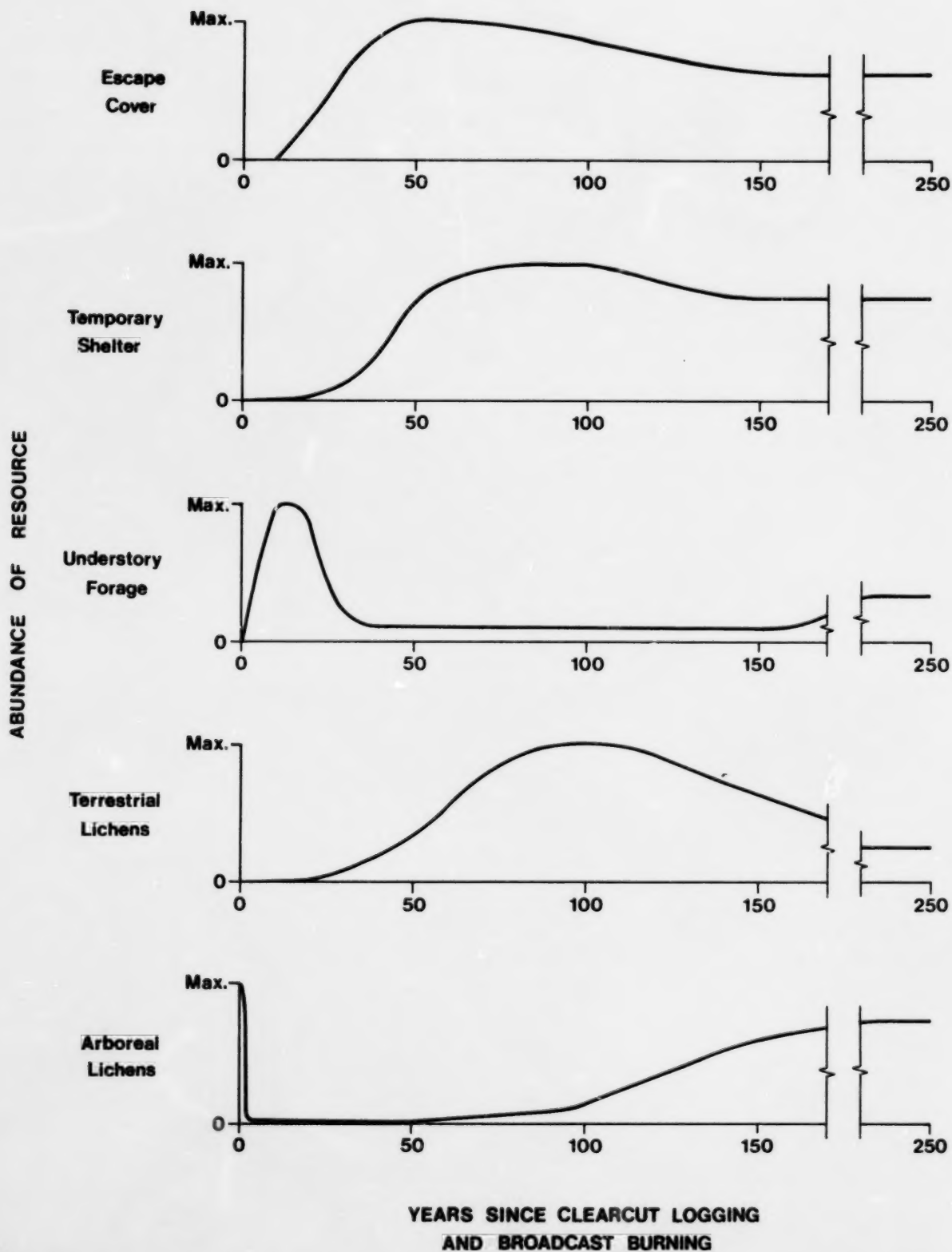
portions of crowns. Those high-elevation forests are commonly used by caribou when a deep, settled snowpack is present; the crusted snow improves access to lichens as well as permitting travel. The strategy of feeding on arboreal lichens in subalpine forests during winter has the advantages of removing the mountain caribou from competition with other ungulates, and making them less accessible to predators.

Arboreal lichens are markedly more abundant in older forests than in second-growth (Fig. 12). When a lichen-bearing stand is harvested, large amounts of lichen forage are briefly available on felled trees, and caribou readily use that food source. After clearcut logging, arboreal lichens from adjacent stands of mature timber colonize the regenerating trees, but do not become abundant enough to be a significant forage source for many years. Because arboreal lichen abundance is difficult to quantify, few studies have related lichen availability to stand age. Existing data suggest that arboreal lichens (Fig. 12) do not become abundant until after at least 100 years, and sometimes much longer (Edwards et al. 1960; Scotter 1962; T. Antifeau, unpubl. data). It is unclear why the lichens do not become abundant earlier. Microclimatic conditions in the young stand, unsuitability of the bark of rapidly growing young trees as a substrate, dispersal limitations in large clearcuts, and the slow growth rates of the lichens themselves may all play a part.

In the western portion of the study area and east of the Rocky Mountains, terrestrial lichens are more important than arboreal lichens in the winter diets of northern caribou (Fig. 1). Use of terrestrial lichens is associated with relatively low snowdepths or with windswept ridges where caribou can dig through the snow (crater) for food. Terrestrial lichens occur in some coniferous forests, as well as alpine tundra and other open habitats.

The place of terrestrial lichens in forest succession is known primarily through studies of fire ecology, reviewed recently by Kelsall et al. (1977) and Viereck and Schandelmeier (1980). Although there is considerable variation among sites, stands capable of producing an abundance of terrestrial lichens commonly do so beginning between 20-60 years and continuing through 100-130 years after burning (Fig. 12) (Ahti and Hepburn 1967; Maikawa and Kershaw 1976; Viereck and Schandelmeier 1980). In late succession, some

FIGURE 12. Stand age and forest resources important to caribou.



stands develop a closed spruce canopy, which favors the development of mosses rather than lichens. Klein (1982) distinguished between the short-term negative effects of fire in destroying terrestrial lichens and other forage plants, and its long-term beneficial effects of maintaining forage production and ecological diversity.

For at least two reasons, the literature on terrestrial lichens in relation to forest succession must be extrapolated cautiously to the situation in our study area. First, the generality of research conducted elsewhere in the boreal forest must be assessed. Studies such as that by Parminter (1983) will be useful in assessing the applicability of other studies on fire succession. However, since Parminter grouped mosses and lichens together in his presentation, his findings are of little direct value for our purposes. Second, patterns of post-logging succession may differ significantly from post-fire succession, especially if the site is not broadcast-burned. Season of logging and site treatment affect the nature and degree of disturbance of the ground layer, and are likely to affect the recovery sequence of terrestrial lichens.

Vascular plants are taken as forage except when deep snow makes them unavailable. A variety of green plants are used during the snow-free season; dried grasses and sedges and low evergreen shrubs are most commonly reported in studies of winter food habits. Conifers are no more than a minor component of the diet.

Responses of understory forage to clearcut logging have been reported (Bunnell and Eastman 1976; Thomas 1979); the pattern shown in Figure 12 has been generalized to include herbs and shrubs. Removal of the overstory results in a period of increased forage abundance. Once the canopy of the regenerating stand begins to close, forage abundance decreases and remains low until late succession, when the canopy begins to open naturally. The effects of various forestry practices on this pattern have been discussed by Bunnell and Eastman (1976) and Thomas (1979).

Forests function as temporary shelter by intercepting snow. The movement of caribou from alpine tundra or open-canopied subalpine forests to closed-canopy low or mid-elevation forests in early winter has often been observed (Edwards and Ritcey 1959; Bloomfield 1980b; T. Antifeau, unpubl. data). Interception of snow by the canopy in these cedar - hemlock or cedar -

hemlock - spruce forests benefits caribou by making movement easier, and terrestrial forage more available. Antifeau (pers. comm.) also observed that later in winter, caribou using open-canopied subalpine forests temporarily moved downslope to denser subalpine timber, during heavy snowfalls. In this case, ease of mobility rather than forage availability was probably the primary advantage of the closed-canopy stand because the settled snowpack had already covered the terrestrial forage.

As well as intercepting snow, forest cover tends to prevent wind-packing and crust formation. Snow crusts are detrimental to caribou mobility unless they are strong enough to support the weight of the animals. Stardom (1975) found that in Manitoba, caribou used open black spruce bogs until high winds caused crusting in open areas; after that they cratered for food in mature jackpine stands where the snowpack was thinner and softer. Although snowcrusting as a deterrent to locomotion has not been discussed in the literature on caribou in the study area, it is likely a factor in movements of caribou between open habitats and forested areas, such as those observed by Bloomfield (1979, 1980b).

Snow interception in forests is related to the structural properties of the trees: the surface area of foliage, crown depth and volume, branch characteristics, and needle characteristics (Miller 1964). Those same properties of the canopy, as well as of the understory vegetation, are probably also instrumental in minimizing crust formation by sheltering the snow surface from wind and solar radiation. In general, the value of a forest stand as temporary shelter is low during early succession, increases until the canopy begins to open naturally, then decreases slightly (Fig. 12) (Bunnell and Eastman 1976).

The use of forests as escape cover by woodland caribou is poorly understood. Bergerud (1974) reported that woodland caribou moved to open habitat in response to disturbance in Labrador, Quebec, Newfoundland, and Ontario. He considered that behaviour, along with gregarious herd structure, to be an adaptive response to wolf predation in an environment where most habitat is open. Such a response would not necessarily be expected where aggregations of caribou are small, and forested habitat is abundant. Stelfox and Bindernagel (1978) reported a number of human-caribou encounters in which the animals ran toward trees, apparently using them as cover. They observed

that reaction to humans was more intense in an alpine tundra environment than in a delta-grassland environment, and hypothesized that the difference was related to the proximity of forested escape terrain. J. Kelsall (pers. comm.) noted that in the Northwest Territories woodland caribou almost always ran into the woods, and barren-ground caribou almost always ran into the open, when harassed. Observers in the study area have noted that caribou run toward forest cover in response to aircraft disturbance on at least some occasions (T. Antifeau, K. Child pers. comm.). It is unclear whether the animals are actually seeking cover under those circumstances, or whether the most readily available places to run toward happen to be forested. Regardless of whether the use of forest cover is active or passive, it undoubtedly helps the animals escape detection by hunters and predators.

In Newfoundland, caribou apparently used forest cover for relief from insect harassment during summer (Bergerud 1974). Caribou in the study area are most often found on snowfields during fly season, but forest cover may sometimes serve this function. Hatter (1979) observed that Tweedsmuir Park caribou apparently sought forest cover to escape insects. The function of forest cover in reducing insect harassment may be related to the activity patterns of warble flies (Oedemagena tarandi): according to Kelsall (1975), warble fly flight is inhibited by winds in excess of 3.2 km/hr, temperatures below 13-15 C, and light intensities under 5000 lux. On calm days, forests would offer more relief from warble flies than open areas.

Like temporary shelter, the value of a forest stand as escape cover is typically highest in mid-succession, after which it declines slightly (Fig. 12) (Bunnell and Eastman 1976). That relationship probably applies to relief from warble fly harassment as well, although not necessarily to other insect species.

Two aspects of the forest resources important to caribou are particularly characteristic of older stands. First, arboreal lichens as forage are unique to mature forests. Second, the ability to provide both forage and temporary shelter is difficult to duplicate in second growth. A trade-off exists between canopy cover and understory forage: the absolute abundance of forage is greatest in the open, but its availability during periods of snow increases with canopy closure because of snow interception. In the CWH zone, old growth forests offer a better compromise between temporary shelter and forage

availability for black-tailed deer than do second growth stands (Bunnell and Jones 1984). The observed use by caribou of old-growth forests in the ICH zone (Pojar 1983) under soft snow conditions probably represents a similar compromise.

3.2 Caribou/Forestry Management Options

A variety of techniques and strategies have been used or proposed to address the special problems of forest management in caribou ranges. Because of the immediacy of the issue for managers in the range of mountain caribou, the following discussion is focussed on the problem of extracting timber while maintaining arboreal lichen production and other caribou habitat values.

3.2.1 Partial cutting

Partial cutting has been proposed as a technique that allows timber harvesting in caribou range, but leaves a residual stand of lichen-bearing trees. In parts of the Nelson and Kamloops Forest Regions diameter limit logging is prescribed in caribou ranges in the Engelmann Spruce - Subalpine Fir Zone (Pojar 1983). Partial cutting has also been done in the study area for reasons other than caribou management. In the Nelson Forest Region, it is sometimes used for silvicultural and watershed protection reasons. In most regions there are some pre-1966 cutblocks that retain a stand of residual trees and are a potential source of information about the effects of partial cuts. Most of that older logging is at low elevations.

The use of partial cutting rather than clearcutting is thought to reduce the adverse impact of forest harvesting on caribou for two main reasons. First, some arboreal lichen remains available as forage. Taking into consideration the removal of harvestable trees, felling of snags, damage to residuals, and loss of forested areas to roads and landings, Stevenson (1979) estimated that in three Engelmann spruce - subalpine fir stands, a partial cut to 20-in. (51-cm) diameter at stump height would result in the retention of 20-32% of the lichen biomass that was originally available. The value of that forage supply to caribou is unclear. Caribou have been observed to travel through logged areas in winter and to feed on lichens from the residual timber (Stevenson 1979). However, the consequence of a reduced and dispersed forage supply is an increase in the energetic cost of feeding. The implications of

this cost to caribou have not been examined, either theoretically or empirically.

The second reason for using that harvesting method in caribou ranges is that the lichen resource is expected to recover more quickly after partial cutting than after clearcutting. Lichens on residual trees provide a source of propagules for dispersal to the remaining timber. The advance regeneration offers a suitable substrate for lichen colonization sooner than would new seedlings. Furthermore, partial cutting may improve the ecological conditions for lichen growth in the lower part of the canopy. Alectorioid lichens are limited, among other factors, by light and moisture (Ahti 1962; Ahti and Hepburn 1967). Their typical distribution in closed-canopy stands in the study area -- abundant high in the crown and less abundant low in the crown -- indicates a light limitation in the lower part of the canopy. In dense or moist stands, but not in open-canopied or xeric stands, partial cutting is expected to result in increased lichen growth in the lower part of the crowns of residual trees (Ahti 1962; Ahti and Hepburn 1967). Palmer (1982) attempted to compare lichen abundance in partially cut stands of various ages, but confounding factors and methodological problems prevented her from reaching any firm conclusions. More work is needed to confirm this hypothesized effect and to determine the relationships among site characteristics, intensity of cutting, time since cutting, and biomass of available lichens.

The potential effects of partial cutting on caribou range must be assessed within the overall harvesting plan. If a second cut is planned within 20-40 years, as suggested by Monteith (1979) for two-storied Engelmann spruce - subalpine fir stands in the Kamloops Forest Region, lichens may never recover to preharvesting levels, or the period during which they are abundant may be brief. Because most trees will be cut before they are overmature, windfallen trees -- a concentrated source of forage lichens -- will be rare after successive partial cuts. Except where Allowable Annual Cuts are reduced, partial cutting will likely mean that larger areas are harvested at any one time so that volume commitments to industry can be met. The concomitant increase in areas accessible by road may offset any benefits to caribou from partial cutting rather than clearcutting. Furthermore, where several successive entries are planned, roads must be maintained in a usable condition for some time.

Partial cutting has a number of implications for forest management and silviculture. Economically, road costs per volume harvested would increase unless strip harvesting was substituted for the usual block layout. Monteith (1979) estimated that in caribou ranges in the Kamloops Forest Region, road costs would increase by 33-50% if diameter limit cutblocks were used instead of clearcuts, but would drop by about 17% if diameter limits were used with a strip system. Harvesting costs may also be increased because of constraints on the selection of logging equipment, and the necessity of protecting the residual stand.

Windthrow is a common problem in stands that have been recently opened by partial cutting. Trees that have developed together in closed stands mutually protect one another, and may not be able to withstand sudden changes in exposure to wind. In general, susceptibility to windthrow is greatest in dense stands, on shallow or poorly drained soils, and on exposures that are not protected from prevailing winds (Alexander 1973). As well as defeating the management objectives for which partial cutting rather than clearcutting was chosen, windthrow results either in lost volume or in salvage costs. Windthrown trees that are not salvaged provide breeding grounds for spruce beetles and may cause epidemics (Alexander 1973; Safranyik 1981). Severe blowdown may impede caribou locomotion. Typically, windthrow in partially cut Engelmann spruce - subalpine fir stands has increased as the intensity of cutting increased (Alexander 1973). Alexander (1973; 1974) prepared detailed recommendations for partial cutting, which depend on canopy structure, spacing, and windfall risk. That approach requires a site-specific appraisal of the stand, marking of individual trees or groups of trees to be cut, and close supervision of logging. A windfirm stand is achieved through a series of light preparatory cuts which open the stand gradually.

Several silvicultural problems may result from partial cutting. The residual stand may be damaged during logging or may fail to release. Alexander (1974) recommended measures for protecting residuals. The implications of partial cutting for growth and yield of spruce and subalpine fir in the study area are not entirely clear. In general, the presence of an overstory tends to favour subalpine fir, a species of lower commercial value, over spruce. However, an overstory may benefit spruce on some sites.

At high elevations (2750-3350 m) in the central Rocky Mountains of the United States, spruce does not establish itself readily in the open. The major factors causing seedling mortality -- high light intensity, high soil surface temperatures, summer drought, and frost damage -- are mitigated by the presence of a residual stand (Alexander 1974). For this reason, a shift in harvesting practices from clearcutting to partial cutting is occurring in subalpine forests in the central Rocky Mountains (Anonymous 1983). Although the problems of excess light, heat, and drought decrease at higher latitudes, where Engelmann spruce-subalpine fir forests occur at lower elevations, they can be significant in the study area. Soil surface temperatures in excess of lethal levels for spruce seedlings occur in British Columbia, especially on burned seedbeds (Smith 1955; Utzig and Herring 1974). Heat and drought mortality of spruce seedlings has also been reported in adjacent Alberta (Day 1963). The presence of a residual stand can help prevent damage to seedlings from excessively high or low temperatures. In contrast, in the SBS zone in the northern portion of the study area, soil temperatures high enough to be lethal to seedlings have not been observed, and soil-moisture deficits are not considered a problem (McMinn 1982). There, removal of vegetation is expected to improve seedling performance by increasing both insolation and temperature.

From the standpoint of silviculture, partial cutting may be a reasonable option on some sites in some parts of the study area. If it is to be used as a management tool in caribou ranges, a problem analysis is needed to assess geographic and site variations in the silvicultural implications of partial cutting. Partial cutting has the potential of minimizing the loss of the lichen resource, but not without some costs to timber management. If partial cutting is accompanied by an increase in the area harvested at any one time, then the benefits to caribou of lichen retention must be weighed against the risks that result from increased access.

3.2.2 Retention of advanced regeneration and non-merchantable trees

An alternative to partial cutting is managing for future lichen crops by protecting the advanced regeneration and by retaining as many lichen-bearing snags and low-value subalpine fir trees as possible.

That technique is not expected to result in as great a lichen crop as partial cutting, but offers advantages over clearcutting. Palmer (1982)

recommended that to ensure adequate lichen abundance, many lichen-rich, medium-vigour subalpine fir of 28-cm DBH or more should be retained. Some trees in that category are not merchantable. Under that alternative, all lichen-bearing subalpine fir trees of little or no commercial value would be left standing. Stevenson (1979) reported that 13-25% of the lichen biomass available to caribou in three mature Engelmann spruce - subalpine fir stands occurred on snags. Retention of as many lichen-bearing snags as possible is recommended. Protection of the advanced regeneration does not increase short-term lichen availability, but is expected to hasten recovery of the lichen resource. From the standpoint of caribou management, the approach offers one advantage over clearcutting: since successive entries are not required, closure of roads after harvesting is an option.

The short-term cost of that approach to forestry is limited to the measures required to protect the advanced regeneration. The silvicultural consequences are variable. Advanced regeneration in Engelmann spruce - subalpine fir stands is dominated by subalpine fir. Although reforestation programs at high elevations have generally been aimed at spruce, they have experienced inconsistent seed sources for natural regeneration, and high failure rates in planted stock. On some sites, the use of advanced regeneration may be a cheaper and more reliable method of restocking (Utzig and Herring 1974). Protection of advanced regeneration is currently practised on some sites in some regions.

In the Kamloops Forest Region, research is under way to determine which ecosystem associations are best suited to utilization of subalpine fir advanced regeneration (J. Robinson, pers. comm.). Silviculturally, retention of larger, unmerchantable subalpine fir is undesirable -- they occupy growing sites without contributing to the value of the stand, and may be a source of poor genetic material.

This technique may be an option where management for lichen crops is considered important, but where partial cutting is unacceptable.

3.2.3 Harvesting of very small patches

Clearcutting of very small patches (1-2 ha) is a management option that has been recommended for subalpine forests where water yield is a primary

consideration (Alexander 1973, 1977). That forestry practice also has the potential of enhancing lichen production.

Creating a number of small, dispersed openings would increase light penetration into the remaining stand of mature timber. Except in stands that are already open or very dry, increased solar radiation is expected to improve the microclimate for lichen growth. Dispersal of lichen propagules would not be a limiting factor, as it might be in large clearcuts. As in the case of partial cutting, the long-term consequences for caribou would depend on the timing of later cuts, as well as on the response of the lichens to the changed microclimate. This technique requires more road access than does block cutting -- a serious drawback from the standpoint of caribou and forest management.

In terms of timber economics, Alexander (1977) rated small patch clearcutting as less favourable than block clearcutting, but more favourable than any partial cutting system. Initial road costs are high. Silviculturally, the chances of natural regeneration are greater in very small openings than in larger clearcuts (Alexander 1974). Small patches should be favourable to spruce regeneration. Since the wind does not normally reach ground level in openings of this size (Alexander 1973), blowdown should be minimal. On sites where slash burning is required, fire control may be a problem.

3.2.4 Extended rotation

Because arboreal lichens are not abundant in stands aged less than 100-150 years, the second-growth forests of the future will typically be harvested before or shortly after they become useful to arboreal lichen-eating caribou as foraging areas. For this reason, an extended harvesting rotation of 250 years has been proposed as an option for timber extraction in caribou ranges (Ritcey 1976).

Under a 250-year rotation, any given stand would be useful to caribou as a foraging area approximately half the time. Ritcey (1976) assumed that only stands older than 150 years are useful to caribou, and calculated that under a 200-year rotation, 25% of the harvestable forest would be useful to caribou at any one time; under a 250-year rotation, 40% of the harvestable forest would be useful to caribou. These calculations are based on the assumption that

harvested areas are clearcut. Extended rotations could also be used in combination with a partial cutting system, so that harvested areas had value as caribou range for a longer period.

The cost of extending the harvest rotation is high in terms of growth and yield of timber. If no growth is assumed after 150 years, then changing the rotation from 150 to 250 years would decrease the contribution of a stand to the allowable annual cut from $1/150$ to $1/250$ of the mature volume -- a drop of approximately 40%. Although the assumption of no growth after 150 years is incorrect, it is true that the annual increment of volume decreases after the optimum rotation period -- older forests grow slowly. Furthermore, older forests are more susceptible to windthrow, disease, and insect infestations than are young forests.

The B.C. Ministry of Forests (1982a) analyzed the overall effects on the wood supply in the Kamloops TSA of three management scenarios for that 4% of the productive land base identified as high priority caribou habitat. The scenarios were:

1. The total productive land base is managed on an ordinary rotation; i.e. harvesting occurs at the time of culmination of mean annual increment.
2. High priority caribou habitat is managed on a 250-year rotation.
3. High priority caribou habitat is excluded from harvesting.

Scenario 1 resulted in a Long Run Sustained Yield (LRSY) that was 22.3% lower than the initial Allowable Annual Cut. The falldown occurred at 100 years. Scenario 2 resulted in a falldown of 23.4% which began at 80 years and reached the LRSY at 100 years. However, the model allowed the stands in high priority caribou habitat to be logged once they had reached 250 years, even though no alternate area came into production (R. Addison, pers. comm.). Since most of those stands were already older than 250 years, there were few short-term restrictions on logging. If the lichen-bearing stands were withheld from logging until alternate stands reached 250 years, the impacts would be more like those of Scenario 3. In Scenario 3, most of the 25.2% falldown occurred at 80 years, and the rest at 100 years.

The study concluded that the differences among the three options in the impacts on the LRSY's and the harvest schedules were very small. However, high priority caribou habitat represented only 4% of the productive land base in the TSA. On the Supply Block level, the impact of extended rotations would be more severe. Despite the costs to the timber resource, some sort of extended rotation, perhaps in combination with other special forestry practices, is the harvesting option with the greatest potential for successful lichen production in the long-term. It is unlikely that special practices, such as partial cutting or very small patch logging, will ensure a usable supply of forage lichens if the stands are harvested as soon as they become merchantable.

3.2.5 Progressive partial cutting

In large unlogged areas where caribou management is a high priority, progressive cutting -- at least some of which must be partial cutting -- is an option to consider.

Progressive cutting concentrates harvesting in a single watershed until its timber supply is exhausted, leaving other watersheds undisturbed for some time. The advantage to caribou is that the adjacent drainages continue to provide undisturbed, unroaded habitat while the first area is under development. If the first drainage is clearcut, then lack of suitable substrate and of propagules may prevent lichen re-establishment in the second growth. But if partial cutting is practised in Engelmann spruce - subalpine fir forests where lichen abundance warrants it, and topography and stand structure allow it, then acceptable lichen crops may be present when the stands mature. There must also be a commitment to delay reharvesting past the time when the lichen supply becomes adequate; without such a commitment, this approach does nothing more than to buy time. This option is feasible only where little development has occurred previously, and unlogged areas are available to remain undisturbed for some time.

A potential disadvantage to caribou is the possibility that the presence of very large areas of unsuitable habitat within their range for many years will result in the abandonment of traditions of use. After the second growth becomes suitable as habitat, there may be a delay before caribou begin using it.

Concentration of timber harvesting, as through progressive cutting, has advantages from the standpoint of forest management (Pearse 1976:279-284). Logging and road costs are substantially decreased. A reduction in the amount of exposed forest edge is expected to reduce losses due to escaped slash fires, unsalvaged blowdown, and epidemics of insects that breed in fallen trees. Although partially cut areas would be vulnerable to those hazards, the net losses would probably not be as great as they are under a patch logging system.

Silviculturally, the consequences of progressive cutting would be variable. Opportunities for satisfactory natural regeneration would be limited. Some foresters (e.g. Anderson n.d.) have argued strongly for progressive clearcutting on silvicultural grounds. However, in some areas and on some sites, especially at high elevations, growing conditions in a progressively clearcut watershed would be severe. In those situations, partial cutting might benefit silviculture as well as caribou management.

Progressive cutting is commonly favoured by foresters and disliked by those who are responsible for the protection of other resource values. Progressive cutting which incorporates partial cutting at high elevations is likely to be viewed less favourably by most foresters. The inclusion of partial cutting in the upper reaches of watersheds would mitigate the impact of the practice on some resources, but not on others. The advantages to caribou of such an approach must be weighed against the impact on other forest values.

3.2.6 Access control

The development of roads in previously inaccessible areas is a serious consequence of logging in caribou habitat. Roads invite human activity in wilderness areas. They lead to increases in legal and illegal hunting. The negative effects of harassment -- intentional and unintentional -- on caribou have been described (Section 2.1.2).

Closure of roads after the completion of logging is inconvenient, but is generally possible. Signs, gates, felled trees, and trenches reduce public use but often do not eliminate it. Drivers of all-terrain vehicles are known for their ability to remove or circumvent obstacles. More complete physical barriers are necessary for complete closure. Closing roads is accomplished

most easily if the need for closure was considered before the road was constructed. Roads can be planned to cross streams where they cannot be forded after the bridge is removed, or located along cutbanks that can be blasted onto the roadway.

Deliberate closing of roads after logging has some benefits other than the protection of wildlife: it reduces the risk of man-caused fire, and allows roads and skid trails to revert more quickly to growing sites. On the whole, it is undesirable from the standpoint of forestry because it eliminates access for purposes of stand tending, fire fighting, and other management activities. Road closure is also strongly resented by the public. Despite its drawbacks, it is technically feasible in most cases, and is an option that should be considered where caribou management is a high priority. It is possible that the effects of access on caribou are so severe that there is little value in modifying logging practices to maintain caribou habitat unless road closure is included in the management plan.

3.2.7 Reserves

Where caribou management is a very high priority, the most effective management action may be the reservation of some areas from human activity. The constraints that appear to be necessary for a very conservative level of management -- some combination of partial cutting, extended rotation, and access control -- may be unacceptable to timber managers. The effectiveness of even these constraints is somewhat uncertain. It is not clear that partial cutting, or any other method for retaining lichens, will be successful after several rotations. If caribou survival in parts of the study area depends on a supply of arboreal lichen forage, and if lichen growth is inversely related to tree growth, then there is a basic incompatibility between the objectives of timber management and the objectives of caribou habitat management. Because reserves are extremely costly, it is essential that the best available information on design of reserves be considered before any are selected.

Applications of island biogeography and related ecological theory to caribou management are discussed further in Section 5.2.

3.3 Information Needs

The discussion of alternatives for managing forests within caribou ranges suggests a number of areas in which managers need information in order to select and implement options:

- What are the relationships among stand age, other characteristics, and arboreal lichen abundance?
- What factors limit arboreal lichens in second growth? Can second growth be managed in such a way as to produce arboreal lichens earlier?
- How do terrestrial lichens important to caribou respond to forestry practices in British Columbia?
- What are the energetic implications, to caribou, of reducing and dispersing their forage supply by partial cutting in lichen-bearing stands?
- Does partial cutting result in increased lichen growth in the lower part of the crowns of residual trees? If so, what are the relationships among site characteristics, intensity of cutting, time since cutting, and biomass of available lichens?
- What is the relationship between growth rate of the substrate trees and growth rate of the arboreal lichens they support?
- In what geographic areas and on what sites is partial cutting a valid silvicultural option in Engelmann spruce - subalpine fir stands?
- Do arboreal lichens establish themselves more rapidly in small openings than in large openings? To what extent is dispersal a limiting factor in lichen re-establishment?
- What is the relative impact on caribou of access vs. habitat alteration?
- What is the optimum size, shape and arrangement of habitat reserves for caribou?
- How much forage (arboreal lichens, terrestrial lichens, vascular plants) is required to support a caribou under winter conditions in the study area?

3.4 Conclusions

The special forest management practices that have been considered here apply primarily to the ranges of mountain caribou, and involve a tradeoff

between forest economics and the objectives of caribou management. In general, those that are most likely to be effective in maintaining caribou habitat have the most severe economic consequences. There are no easy solutions to the problem of extracting timber from caribou ranges while maintaining caribou populations, at least where arboreal lichens are judged essential.

The consequences of special forestry practices must be considered within the framework of an overall, long-term management plan. Unless the objectives are merely to buy time for caribou, the effects of practices intended to retain forage lichens must be forecasted through several logging passes or rotations. In caribou ranges that are managed for lichen production, it will probably be necessary to defer some harvesting past the time that is optimum for timber production. For management strategies that require foregoing available timber at some time in the future, there is a practical problem of ensuring a long-term commitment to the strategy.

Wildlife managers must take into consideration the tradeoff between special forestry practices intended to encourage lichen production, and increased road access to caribou ranges. Except where the Allowable Annual Cut is reduced, the use of practices such as partial cutting and very small patch logging will result in an access increase in the area that is under development at any one time. The result will be greater human disturbance for an extended period of time, unless access control is practised. To a great extent, the management strategy selected must depend on the relative importance we assign to the effects of habitat alteration and human disturbance. That is a major research question that must be addressed.

4 EVALUATION OF THE INFORMATION BASE

Our understanding of caribou in the study area is at a preliminary stage. Most research has been general in nature, aimed at identifying basic ecological relationships: population characteristics, seasonal habitat use, food habits, movement patterns. Our knowledge of caribou is limited partly because funding priorities have not encouraged intensive study. In addition, persons trying to inventory caribou and study their ecology have encountered a number of methodological problems. In this section, we examine the existing information base in terms of those problems, of which some are general and some specific to caribou.

4.1 Population Data

A pervading theme throughout the regional population discussions (Chapter 2) was the fragmentary, inconsistent and generally inconclusive nature of most of the information. Historic references to numbers are mostly anecdotal and/or subjective, and most are too scattered both in time and space to enable certain distinction between possible population changes and range shifts. More recent data, having been produced by a variety of methods on an irregular basis, are difficult to compare. As appears to be the case throughout the range of woodland caribou (Hatler 1983), the lack of a reliable and consistently applied inventory system has been a major impediment to our understanding. The need for good information seems obvious enough, but the reasons for its relative absence are less so. Following are some of our thoughts on the matter, including how administrative constraints and biological characteristics have interacted to make caribou management in British Columbia particularly difficult:

1. Wildlife management assignments in British Columbia are on the basis of geography rather than species. There are two potentially serious consequences:
 1. Each biologist is responsible for several species in his area. Since time and budget are always limiting, he must give priority to his activities and divide his attentions. It is difficult to

generate good field data for a lower priority species with only minimal contact, and especially by ad hoc methods.

- ii. Individuals of one species are potentially "managed" by up to several biologists over a lifespan, and even over one annual cycle in the case of mobile species. There is therefore a continuing danger of exposure to inconsistent approaches and/or conflicting objectives, particularly where it is not known that the same animals occur in more than one administrative unit.
2. Few administrative units for wildlife in British Columbia were established with caribou management specifically in mind. If some were, it is apparent that they were instituted without full knowledge of population movements and ranges. Some consequences:
- i. Incomplete Inventories - generally, local managers do not have the budget, time, or mandate to conduct counts in other jurisdictions (e.g. other regions, parks), so census efforts often stop at those boundaries, even when animal distribution does not. This problem is made worse when two adjoining jurisdictions potentially sharing a population either make counts at different times, or one does not count at all.
 - ii. Lack of Perspective - since most administrative units are probably smaller than population ranges, and since most management needs (especially as they relate to habitat) are site specific within administrative units, the manager is forced to think small. It is possible to do all of the right things in unit A and still lose the animals by doing something wrong in unit B.
 - iii. Management Overlap (see item 1, ii) - lacking knowledge on the extent and nature of population sharing, it is theoretically possible for two adjoining jurisdictions to take management actions which are redundant (e.g. both preserving a particular resource when that resource is only required in one of them) or damaging (e.g. each applying the same harvest rates to the same population, thereby doubling hunting impact).

3. Despite the presence of a specific provincial plan relating to objectives and guidelines for caribou management (B.C. Ministry of Environment, Fish and Wildlife Branch 1979a), there is no established technology or co-ordinated system for gathering the data required to adequately implement that plan. Each jurisdiction is essentially on its own to generate its own information as required. Lack of continuity between areas therefore occurs, and there may also be a lack of continuity within, upon changes in personnel. Further, the mandate and budget of local managers is to do surveys, not to find out when and how best to do them, so that many of the actual surveys that have been done have been at least inefficient and probably inaccurate. Some may also have been inappropriate in the local context. Given the possibility (if not likelihood) of seasonal movements in most areas, managers concerned about loss of winter habitat may not learn much from summer surveys, and those interested in establishing harvest strategies for particular areas might need to look beyond their own boundaries, and in more than one season, to obtain the pertinent data.

The foregoing points are generalizations for background only. They are clearly not mutually exclusive, and not all points are applicable to all census attempts which have been undertaken in the present study area. Some useful minimum counts have been made, one region (Region 3) has developed and maintained an inventory system, and the attempt in 1982 to undertake a co-ordinated survey by personnel from Regions 3, 5, and 7 in their area of mutual interest must be mentioned. However, as shown in Chapter 2, our present knowledge in most areas is limited to a minimum count or "estimate" for some specified area, but with no basis for any objective measure of reliability, no clear understanding of how such figures for adjacent areas may relate to each other, and no certain basis for comparing recent figures with those generated previously.

The word "estimate", as used above, requires some discussion. The data described in the population sections of Chapter 2 included no estimates in the statistical sense, i.e. no population extrapolations from systematic samples. Rather, they are all ad hoc estimates resulting either from 1) subjective

expansion of a minimum count to a new total, including the number (or percentage) the observer believed he might have missed, or 2) summation of a series of local observations, within the area of reference but usually scattered in time. Combinations of these two estimates are sometimes employed, with summations being fortified by subjective expansions.

In our view, in the absence of marked animals or a completely homogeneous distribution, the subjective expansion factors are pure fiction. The summation system, which assumes that caribou occur in more or less discrete and identifiable bands, is more factually based, but it suffers from many of the difficulties described earlier, including the channelization of thought imposed by administrative boundaries. Since most of the actual data on numbers in the study area (and all of that pertaining to Regions 4 and 7) is in the form of scattered, incidental observations, an example is warranted:

A theoretical subject area is composed of units A and B, each divided into sub-units a, b and c. Six observations, one in each sub-unit, are reported, as follows: A(a)-25 caribou on 6 January 1983; A(b) 18 on 6 March; A(c)-10 on 6 May; B(a)-17 on 6 July; B(b)-21 on 6 September; B(c)-14 on 6 November. By the summation method, minimum populations for the two units would be calculated as A:25+18+10=53 and B:17+21+14=52 (Grand total:53+52=105). On the basis of additional information provided by observers (fresh sign seen outside the count areas; the fact that some animals were believed to have taken cover before a group was counted, etc.), that minimum total might be "expandable" to 125, 150, or even larger. However, note that the above observations were two months apart, and thus there was considerable time for at least some animals to move between count areas and be counted more than once. Indeed, assuming no impassable barriers between any of the six subunits, and lacking any marked animals, the maximum number which can be documented with certainty is that from the first observation (25).

It is important to consider the dilemma of the manager armed only with such uncertain data, and with no means for improving it before some management decision must be made. There are risks to the animal of assuming that either end of the above range (25-105+) is closer to the true population. The risk involved in setting hunting regulations on the basis of 100 animals when only 25 are present is obvious. From the standpoint of habitat protection,

however, the safest interpretation is that each area where caribou were seen supports at least that number, and must be preserved. Further, since management decisions often involve weighing the importance of two competing resources, a scientifically rigorous minimum figure such as the 25 in the above example is not likely to yield any benefits for the caribou. In our view, the currently low hunter opportunity (Section 2.10.1) and high habitat protectiveness in the study area are consistent with, and appropriate to, the uncertainty in data which we have described.

To summarize, the available information on caribou in the study area is inadequate to accurately describe past populations or to quantify changes that have occurred even up to the present. That is, although it seems clear enough that there are fewer animals in southern British Columbia now than there once was, we will likely never know any more than that, and better results between now and some future time are not assured. We have identified some major factors that exacerbate population interpretation in the area, including the geography-oriented nature of British Columbia wildlife administration and the potential mobility of the animals. On the latter point, evidence from studies elsewhere suggest that study area animals may regularly move over larger areas than some people apparently expect. However, we emphasize that the truth has yet to be established, and we even speculate that expanding human developments, including the proliferation of human transportation corridors, could have produced selection pressures favouring sedentary phenotypes in some local areas.

Overall, the initial need regarding caribou numbers in the study area is identification and description of the actual populations present, as defined by biological rather than geographic criteria. That will basically require marking and regular monitoring of animals by researchers and managers. However, we believe that such an effort can be enhanced by development of public assistance programs. Observations from people who regularly work or spend time in areas of known or suspected caribou range can supplement local knowledge on distribution, seasonal ranges, movements and occasionally numbers of the animals. Following are some suggestions:

- a) Provide local information and report forms to knowledgeable people working in pertinent areas.
- b) Produce media items and signs requesting assistance.

- c) Provide questionnaires for hunters asking what they saw rather than just what they shot.
- d) Initiate or increase limited entry hunting in some cases, both to enable collection of biological information and possibly to reduce poaching by insuring that responsible and interested people are in the area and available to report violators.

4.2 Management Data

As stated above, it is difficult to find and distinguish between groups of caribou over large expanses of mostly forested habitat, and the poor quality of the available information on numbers is at least understandable. Data on population dynamics within the study area have also been sparse, and for much the same reasons since the sources (surveys and observations) are the same. The primary information available on management of the species, that relating to hunting pressure and kill, also has serious deficiencies. As discussed in the various regional accounts (Chapter 2), the following were prominent and pervasive problems:

1. Administrative boundary changes: Since detailed hunting statistics were first compiled in the annual Hunter Sample reports, there have been three major changes in management unit boundaries (Appendix 2), resulting in loss of continuity and uncertain comparability. Also, because the units were very large through 1974, data were not as area-specific as our analyses required.
2. Inconsistent Guide Data: Data on the kill by guided hunters were not in a readily retrievable form for most years (J. Bone, pers. comm.). The Hunter Sample volumes for 1965-67, 1970, and 1974, which included guide summaries, indicated that guides were involved in a significant proportion of the total hunter kill in at least some areas in the 1960's; thus that gap is serious. Further, because residents were among the guided clients in that period (A. Blackwell, pers. comm.), there is potential overlap between resident estimates and guide reports for those few years in which both sets of data are available. The extent of such overlap is unknown.

To improve understanding of hunting patterns and possible effect over the years, a special effort should be made to determine whether original Hunter

Sample questionnaires and guide declarations are still available. If those prior to 1975 are, all data should be entered into the present system, and the capability for cross-referencing between GMAs, MAs, and present management units should be developed for all data up to the present.

As detailed in the regional accounts, there is evidence that excessive harvests, resulting in population declines, have occurred in several areas. However, that evidence has been mostly subjective. The absence of accurate data on numbers and population dynamics precludes analysis in most cases, and even in those instances in which the harvest data have been thought to confirm overharvest allegations, a critical look has found inconsistencies. That is, either the allegations or the data were wrong.

The most common conflict among the harvest data has been the failure of kill sex ratio figures to reflect alleged harvest pressure. Because female caribou usually have antlers, they have doubtlessly been confused for males at least occasionally, and Bloomfield's (1979) long disclaimer of the sex-of-kill data is based on that fact. His discussion, primarily a negative view on the competence and integrity of hunters, is speculative. There were substantial either-sex seasons throughout the period when the overharvests are supposed to have occurred (late 1960's-early 1970's, Vol. 2, Appendix 4), thus there are no compelling reasons why most hunters should have failed to report females, even if they killed them "by mistake". We do not argue that the sex data are accurate. Rather, we argue against selective use of available harvest data. The basic premise of the Hunter Sample system is that hunters are honest, and that premise should not be questioned only for those parts of the data which do not fit particular ideas.

We believe that if there are errors in the Hunter Sample data, they are more likely related to sampling problems. Several potential sources of bias, acting singly or in combination, are envisioned:

1. **Sampling Intensity:** As shown in Tables 14 and 15, caribou harvest data for the province during the years of highest harvests were based on questionnaire replies from only about one-third of all licensees, and only a small proportion of those are applicable to any one administrative unit (former MA 20 in present Region 7 is used as an example).

TABLE 14. Aspects of sampling for caribou hunting statistics in British Columbia and MA 20 (established in 1967), 1964-1974. Data from Hunter Sample, B.C. Fish and Wildlife Branch, Victoria, B.C.

Years	Total licenses	Sampling levels ^a (%)		% Non-hunters ^b	Active hunters (est)		Estimated kill	
		Theoret.	Actual		Prov. No.	MA 20 No.	Prov. No.	MA 20 No.
							(%)	(%)
1964	2219	94	50	29	1583	-	465	-
1965	2365	100	49	29	1683	-	523	-
1966	2971	94	44	27	2235	-	798	-
1967	4341	84	33	24	3670	489	1191	121
1968	3325	87	34	22	2725	299	830	58
1969	3270	80	31	23	2890	427	854	98
1970	3591	83	35	28	2787	301	949	78
1971	3816	84	35	30	2742	258	1000	76
1972	4702	84	29	28	3579	258	1080	40
1973	7398	69	29	36	4846	303	1295	50
1974	3376	89	29	27	2472	170	531	21

^aTheoret. = Proportion of licensees sent questionnaires; Actual = proportion of licensees returning questionnaires.

^bProportion of respondents who reported that they did not hunt.

TABLE 15. Caribou harvest data for MA 20 (Region 7), 1967-1974. Data from Hunter Sample, B.C. Fish and Wildlife Branch, Victoria, B.C. Figures are estimated (E) numbers of hunters and caribou killed and numbers of actual respondent replies (R) on which the estimates were based, organized by areas of hunter residence^a.

Year	Island - Mainland			South Interior			Kootenays			Other			North		
	Hunt.	Kill	Succ. ^b	Hunt.	Kill	Succ.	Hunt.	Kill	Succ.	Hunt.	Kill	Succ.	Hunt.	Kill	Succ.
1967	94(36)	26(10)	28	72(30)	12(5)	17	0(0)	0(0)	0	3(1)	0(0)	0	320(89)	83(23)	26
1968	79(26)	2(1)	3	28(12)	7(3)	25	7(3)	2(1)	29	6(2)	0(0)	0	189(53)	47(13)	25
1969	69(23)	21(7)	30	54(20)	13(5)	24	9(4)	2(1)	22	0(0)	0(0)	0	295(71)	62(15)	21
1970	51(19)	6(2)	12	55(17)	12(5)	22	12(5)	2(1)	0	7(2)	0(0)	0	176(58)	58(19)	33
1971 ^c	34	17	50	37	8	22	8	3	38	7	4	57	172	44	26
1972	23(7)	0(0)	0	30(10)	13(4)	43	18(3)	6(1)	33	0(0)	0(0)	0	187(61)	21(7)	11
1973	44(19)	4(2)	9	46(12)	8(2)	17	5(2)	0(0)	0	0(0)	0(0)	0	208(60)	38(11)	18
1974	20(10)	0(0)	0	25(6)	0(0)	0	4(2)	2(1)	50	3(1)	0(0)	0	118(25)	19(4)	16

^aIsland-Mainland = Vancouver Island and the Lower Mainland area in SW B.C.; So. Interior = Okanagan, Kamloops, Cariboo - Chilcotin; other = Peace River and Upper Mainland Coast; Kootenays = southeastern B.C.;

^bSuccess = No. caribou estimated killed - no. estimated hunters x 100

^cData on reported numbers of hunters and reported kill not available for 1971.

2. Respondent Representativeness: For the purposes of hunting pressure and harvest projections, it is assumed that the proportion of non-hunters and unsuccessful hunters is the same among the non-respondents as among the one-third who responded. It is more likely, however, that both were higher among the former group.
3. Respondent Independence: The sampling procedure assumes that the success of one hunter is unrelated to that of others, i.e., that the distribution of success within both the sample and the population is random. That assumption is probably close for most species but may not be for caribou in that both hunters and the animals may occur and encounter each other in groups, resulting in multiple kills. One "lucky" group of hunters could greatly influence the apparent success in a small sample for a local area. For example, it was estimated that 34 hunters from southwestern British Columbia took 17 caribou in MA 20 in 1971 (Table 15), but the estimate was based on an actual reported kill of only six animals, a number which conceivably could have been taken by a single party, all members of which received and responded to questionnaires.
4. Casual user effect: The tag license for caribou cost only \$5.00 or less through 1973, thus it was cheap enough to obtain on a speculation basis. That is, a hunter who had no intention of actively seeking a caribou might nevertheless carry a tag in case he saw one. In response to the questionnaire, such a hunter is likely to respond that he hunted caribou only if he shot one -- if he saw none he reports that he did not hunt, not that he was unsuccessful. The result is an inflated apparent success rate and therefore an overestimate of the projected kill.

Table 15, which lists hunter participation and kill data for MA 20 on the basis of the area of residence of the hunters, is presented to illustrate the potential for the biases discussed above. In regard to sampling intensity, the reported figures are never more than half the estimated figures, and are usually less than one-third. The extreme case is the set of data for the Kootenays, 1972, when a sample of three hunters, one of whom killed a caribou, was projected to 18 hunters taking six animals. Although the bulk of the hunting pressure and total kill were attributed to local hunters, some of the

highest success rates posted in Table 15 were by hunters from farthest away. Although that result may be due to more serious effort by the visiting hunters, it is more likely due to some or all of the factors discussed above. Hunters travelling the farthest are at least as likely as the locals to bring caribou tags on speculation, probably spend less time hunting than the locals (who may return repeatedly), and they may therefore be more prone to report as non-hunters if unsuccessful. Also, since the visiting hunters are represented among smaller samples than the locals, the potential impact of the group effect (multiple kills) is greater for them. The widely varying success rates for hunters from southwestern British Columbia are particularly suspicious in that regard. Finally, it should be pointed out that the data in Table 15 are lumped; Hunter Sample compilations for most of the years indicated are for nine rather than just five resident areas, thus pertinent sample sizes for all areas except North and Kootenays are even smaller than those shown.

In conclusion, there are reasons to believe that much of the available data on caribou hunting, as compiled by the Fish and Wildlife Branch in its Hunter Sample program, may not be reliable. Most of the biases we have identified here would tend to result in overestimates of kill. The Hunter Sample may give a reasonable approximation of the distribution and intensity of hunter effort, although that depends on the representativeness of respondents among the sampling universe. The Compulsory Inspection System appears to produce kill data which are both reliable and sufficiently specific to enable the kind of analyses managers need to undertake. It is unfortunate that it was not instituted until most of the present study area had been closed to hunting.

4.3 Habitat Information

Much of the work on the ecology of caribou in the study area has been aimed at describing habitat use and food habits. Those topics may be viewed as levels in a hierarchical framework of selection processes (Johnson 1980). At the highest level is the selection of the geographical range of the species. Second-order selection determines the home range of an individual or group. At the third level, the individual or group differentially uses habitat types available within its home range. The actual procurement of food items from those available at feeding sites is fourth-order selection.

In order to draw inferences about resource selection from studies of resource use, it is necessary to compare what is used to what is available. To do this, methods are required for classifying and quantifying the resources that are available, for quantifying the use of those resources, and for comparing the two. Many methodological problems exist. For those reasons, most of the work done in the study area has focussed on resource use rather than on resource selection.

4.3.1 Habitat use

Studies of habitat use depend on accurate information about the locations of animals. The first major study involving radio-collared animals was begun in the winter of 1978-79; several others are now in progress, but no final reports have been published. Most of the available information on habitat use by caribou has been gathered without the benefit of radiotelemetry. For locations of animals, researchers have had to rely on survey flights, ground observations, and incidental sightings reported to them by members of the public.

All of those methods have serious drawbacks. Data obtained from survey flights are strongly biased toward locations in open habitats -- alpine tundra, parkland, meadows, and muskegs. The problem is compounded during periods when snow is present at high elevations and in openings but absent under forest cover, because snow enhances the visibility of animals and tracks. The ground observations of researchers also have this bias, but to a lesser extent, as initial contact with the animals is more likely in open habitats. Incidental sightings are biased toward open habitats and toward locations frequented by people. Those biases are evident in the sighting maps (Vol. 2), in which observations are clustered in the alpine and subalpine, and along roads.

Those biases must be borne in mind when the results of studies conducted without radiotelemetry are considered. Edwards and Ritcey (1959) described altitudinal migrations of caribou in Wells Gray Park. Their study was based on extensive field work, carried out on foot. Freddy (1979) did not find distinct seasonal differences in elevations frequented by caribou in the south Selkirks. His study depended on aerial surveys, supplemented by ground surveys. No observations were made during December or January -- months when

caribou have often been found at low elevations in other areas. The different results obtained in these two studies may represent ecological differences between caribou in the two geographic areas, or may reflect differences in methodology. Ongoing radiotelemetry studies in the south Selkirks should help to clarify this point.

Conclusions drawn from studies of habitat use are sometimes interpreted as though habitat selection had been studied. The often quoted observation of Freddy (1974) that caribou showed an affinity for slopes less than or equal to 35% was not based on an analysis of the topography of the study area. Likewise, Bloomfield (1979, 1980b) carried out a detailed examination of caribou preferences for elevation, aspect, slope, and vegetation zone without accounting for their availability. Conclusions based on studies such as these should be qualified, as they may reflect the availability of habitat types within the study areas as much as they do the preferences of caribou.

It is easy to identify problems resulting from failure to consider availability of habitat types, but difficult to design a study that does so satisfactorily. Both practical and theoretical problems are involved. The difficulties of classifying habitat types and determining areas can be considerable. Existing classifications, such as forest cover types, may not include the variables of greatest interest to researchers or importance to the animals, but a classification designed specifically for a caribou study may be prohibitively expensive. Digitized mapping systems such as Computer Aided Planning Assessment and Map Production (CAPAMP) and Inter Graph Data System (IGDS), presently under development by the Ministries of Environment and Forests, respectively, are potentially applicable to habitat research.

The outcome of use/availability studies depends on what habitat types the investigator judges to be available to the animal (Johnson 1980). In studies of second-order selection, the proportion of habitat types within an animal's home range is often compared to the proportion available within some much larger area -- an administrative unit or a study area as defined by the investigator. The conclusions will depend greatly on the boundaries that are selected. Furthermore, the spatial arrangement of habitat types within the study area is unlikely to allow the animal to encompass them in its home range in the same proportions that they exist in the study area; the animal could not possibly select habitat types in proportion to availability. There is a

need for special statistical methods to handle the problem of home range selection.

That problem is avoided if the study is limited to third-order selection -- the use of habitat types available within the home range selected by the animal. However, statistical results may be misleading. The fact may be overlooked that a home range is located where it is because of the availability of a particular resource. It is conceivable, even, that the habitat type in which that critical resource occurs may appear to be avoided, if the resource is used infrequently -- such as breeding habitat, or shelter from severe weather conditions. Failure to consider the selection of home range may lead to an incorrect conclusion about the importance of a particular habitat type.

Problems of use/availability studies are not specific to caribou, but are general in the field of animal ecology. There is a need for a review of the theoretical, statistical, and practical aspects of comparing use and availability of habitat types in British Columbia wildlife studies.

4.3.2 Diet

Like studies of habitat, studies of forage have focussed on use rather than on selection. Availability of forage items has been assessed informally, if at all. For most purposes, informal assessments of availability may be an adequate background against which to interpret information on food habits. Managers badly need information on the broad forage groups used, but do not necessarily need details on preferences among species. It is nevertheless important to have methods for quantifying available biomass of forage plants, as they are used to determine carrying capacity as well as food preferences. A variety of well-documented methods exist for quantifying the standing crop of vascular plant forage. Determining the abundance of lichens, especially arboreal lichens, is more difficult. The need for work on arboreal lichen biomass methods has been recognized by the Ministries of Forests and Environment, and a problem analysis is in preparation (Stevenson, in prep.).

Determining the food habits of caribou, even the relative use of broad forage classes, has proven difficult. The methods that have been used in the study area include direct observation of feeding animals, examination of feeding sign, rumen analysis, and fecal fragment analysis. Each of these

methods has drawbacks which should be borne in mind when literature reports are evaluated.

Many researchers have recorded direct feeding observations when they have had the opportunity to do so, but none has collected enough data for a study in that manner. Correct identification of the plants that are used is often impossible at a distance.

Identification of forage utilization from feeding sign is more difficult for caribou than for some other ungulates. First, feeding intensity is often very low, especially in the case of mountain caribou. Second, use of some common forage items is not readily detectable. Grazing of terrestrial lichens is difficult to distinguish from trampling, especially when the lichens are dry or frozen. Winter feeding on dry grasses and sedges is difficult to detect. In winter, evidence of arboreal feeding is easy to see, but it can be impossible to determine which species were taken. When use at a feeding site cannot be positively identified, the observer is faced with a dilemma: does the presence of a given species after feeding indicate that the animal selected a location where the species was abundant, or that the animal ate something else and avoided that species?

Rumen analysis has not been used commonly in the study area, especially in recent years, because it requires samples from hunter-killed or sacrificed animals. Since fecal pellets can be collected easily, without disturbance to the animals, fecal analysis has become the favoured method of determining food habits. The techniques have several disadvantages. Forage preferences of free-ranging animals cannot be determined because the foods that were consumed cannot be related to any particular location. Analysis is time-consuming, and it requires specialized skills and a reference plant collection. Furthermore, the accuracy of the results is questionable. The value of these techniques in representing the botanical composition of the diet of ruminants is the subject of an extensive and somewhat contradictory literature, reviewed recently by Holechek et al. (1982).

There are several reasons why a quantitative assessment of the botanical composition of rumen or fecal samples may not be an accurate representation of the diet of caribou. Plant fragments occurring in the rumen or feces vary in the ease with which they can be identified. Differences in discernability can lead to systematic biases among plant groups. Dearden et al. (1975) reported

that mosses in hand-compounded mixtures tended to be overestimated by technicians because even small fragments were easy to identify.

The most commonly used methods of quantifying botanical composition of rumen or fecal samples are variations of the microhistological technique described by Sparks and Malechek (1968). Vascular plant fragments are identified according to undigestible cuticular fragments that bear characteristics of the underlying epidermal tissue. The technique depends on the assumption of a 1:1 relationship between the proportion of identifiable fragments of a species in the samples, and its percent composition by weight in the diet. That relationship does not exist for all plant species; for example, species with leaves that have a low proportion of epidermal tissue in relation to total biomass would be underrepresented in the samples (Holechek *et al.* 1982). For lichens, which do not have epidermal tissue, it is especially important to test that assumption.

The problem of differential digestion of plant species is widely recognized, but is particularly critical in the case of caribou, which often consume foods of widely differing digestibility (Gaare *et al.* 1977). The lichen Alectoria sarmentosa had disappeared from the rumen of a cow caribou 4.5 hours after ingestion, but Kalmia angustifolia, an evergreen shrub which had been eaten at least 15 days earlier, was present (Bergerud and Russell 1964). Uncorrected, the technique could result in overestimation of the dietary importance of the least digestible food items. Raw data can be corrected if digestibility is known (Gaare *et al.* 1977; Holechek *et al.* 1982). The latter authors recommended that *in vitro* digestibility trials of hand-compounded mixtures be used to correct that kind of bias. However, digestibility trials themselves can be problematic, and the warnings of Trudell *et al.* (1980) regarding errors due to inoculum source, nitrogen limitation, and fermentation inhibitors should be recognized.

Fecal fragment analysis is currently in use in several ongoing studies in British Columbia, and no practical alternative to the technique is apparent. So far, correction factors have not been applied in research using rumen or fecal analysis in the study area. If fecal fragment analysis is needed to meet research objectives in future studies, then a further evaluation of its accuracy is needed. In that case, we recommend a more thorough review of the

published literature than that presented here, and an assessment of the feasibility of developing correction factors.

4.4 Conclusions

Both historic and recent data on caribou numbers are deficient in many ways. The lack of a reliable and consistently applied inventory system is a continuing impediment to our understanding of caribou populations in the study area. There is a particular need for the identification and description of the actual populations present, as defined by functional rather than geographic criteria.

Deficiencies in the existing information on habitat use by caribou have two major causes. First, data on animal locations obtained without the benefit of radiotelemetry tend to be biased against forested and thick shrub habitat. Fortunately, nearly all studies initiated since the late 1970's have employed telemetry. Second, conclusions about habitat selection that are not based on an adequate analysis of use in relation to availability can be misleading. Use/availability studies entail practical, statistical, and theoretical problems, which should be investigated.

Existing methods of determining food habits have serious drawbacks and biases. Fecal analysis has major advantages and is now used commonly in the study area, but its reliability is uncertain. If it is employed in future studies, we recommend an investigation of its accuracy and, if necessary, of the feasibility of developing correction factors.

5 MANAGEMENT ANALYSIS

Although our primary focus in this report is on needs for research, our terms of reference include a consideration of caribou management. Having reviewed the regional approaches to caribou management in Chapter 2, we here offer some thoughts on what could be done at a provincial level to help meet management objectives for caribou. The following paragraphs both emphasize and augment our view that the caribou must be managed on the basis of functional, biological populations rather than on relatively artificial geographic boundaries.

Caribou management in British Columbia is the responsibility of the Wildlife Branch. The overall goals of that agency for wildlife management are to maintain the diversity of species representative of the major biophysical zones of the province, and to ensure that wildlife is available to meet the recreational and economic needs of society (B.C. Ministry of Environment, Fish and Wildlife Branch 1979b). Objectives for caribou management are to increase the population to at least 20 000 animals distributed on traditional ranges, to provide an opportunity for people to view caribou in their natural habitat, and to provide 20 000 hunter days of recreation and an annual sustained hunter kill of about 1000 animals (B.C. Ministry of Environment, Fish and Wildlife Branch 1979a).

The Wildlife Branch has management responsibility for caribou, but it does not have direct control over the land base on which caribou depend. Administrative control over Crown land occupied by caribou is primarily the responsibility of the Ministry of Forests, although the Ministry of Lands, Parks and Housing and other agencies have some jurisdiction as well. The Ministry of Forests is responsible for planning "the use of the forest and range resources of the Crown so that the production of timber and forage; the harvesting of timber; the grazing of livestock; and the realization of fisheries, wildlife, water, outdoor recreation and other natural resource values are coordinated and integrated, in consultation and cooperation with other ministries and agencies of the Crown and with the private sector" (Ministry of Forests Act 1980, Section 4c).

In most of the study area, caribou populations have declined, especially where extensive human activity has occurred (Section 2.10). Numbers are

especially low in the southeastern quadrant of British Columbia, which may support fewer than 1500 caribou of the mountain ecotype. The objectives of the Wildlife Branch for caribou management require it to increase populations on traditional ranges, and its overall goals imply that the species must be maintained in the major biophysical zones in which it occurs naturally. The mountain caribou of southeastern British Columbia represent a special adaptation to the ICH-ESSF-AT complex of biogeoclimatic zones. For this reason, the Wildlife Branch is obligated to work toward the preservation of caribou in southeastern British Columbia, as well as in parts of the province where the animals are more numerous.

Decisions will have to be made about the costs society is willing to incur to ensure the long-term survival of caribou. We believe that the probability of sustaining caribou in southeastern British Columbia will be greatly increased if areas are designated in which caribou management is a high priority. The need for such areas is urgent within the range of mountain caribou. Elsewhere, it is becoming urgent wherever industrial activity is occurring. Because special management areas can be established more easily before rather than after other commitments are made, we recommend early action on this problem.

Managing an area for caribou production can entail high costs, in the sense of foregone opportunities to develop other resources -- at least within the range of mountain caribou. Thus, areas where caribou management is to be a high priority must be selected carefully. The process should take into consideration the implications of ecological theory for the layout of special management areas. It should take into consideration the characteristics of specific caribou ranges -- viability of existing populations, present status of habitat, and land use pressures. In this chapter, we propose an approach designating high priority areas for caribou. First, however, we consider the question of ecotypes and implications to managers of ecotypic differences.

5.1 Identification of Ecotypes

Failure to recognize differences in the way ungulates relate to their environment from one geographic area to another is a common reason for poor management results (Bunnell *et al.* 1978). Bergerud (1978) criticized British Columbia wildlife managers for extrapolating research findings based on

studies of arboreal lichen-eating caribou to the entire province. Although the definitive taxonomic studies of Banfield (1961) place all British Columbia caribou in the woodland subspecies (Rangifer tarandus caribou), significant ecological differences occur within the province. We believe that those differences merit recognition at an ecotypic level. We do not contend that the ecotypic differences in question necessarily have any genetic basis; rather, they may simply be based on the animals' responses to their habitat.

Bergerud (1978) distinguished between caribou that depend primarily on terrestrial forage, including lichens, during winter, and those that use arboreal lichens. That distinction in winter food habits is associated with different habitats and patterns of habitat use, which we consider ecotypic differences. We refer to "terrestrial lichen caribou" as northern caribou, and "arboreal lichen caribou" as mountain caribou. On the basis of recent information (D. King, B. Churchill, B. Fuhr, pers. comm.), we have redrawn the boundary between ecotypes first proposed by Bergerud (1978) to correspond with the break between the Rocky Mountains and the Rocky Mountain Foothills (Demarchi, in prep.) (Fig. 1). Northern caribou typically use winter ranges where the average annual precipitation is less than 76 cm, and terrestrial lichens and vascular forage are available under a snowpack that is shallow enough to permit cratering. That kind of habitat use occurs especially in alpine tundra and in open forest types in the SBS and BWBS zones. Use of large open areas during winter, as well as during summer is characteristic of northern caribou. Group sizes may be quite large; aggregations of 300 or more animals have been reported.

In contrast, mountain caribou occupy a high-snowfall belt in southeastern British Columbia, where average annual precipitation is greater than 76 cm. Arboreal lichens in the ESSF zone are used heavily when the snowpack is deep and supportive. Vascular plants and lichen litterfall in the ESSF, ICH, and SBS zones are taken during soft snow periods. Availability of terrestrial lichens is typically low. Winter habitats are mostly forested, although alpine areas are used during summer. Group sizes are relatively small, and counts of 20 or more animals are uncommon.

An ecotypic difference could be expected between caribou occupying mountainous habitats, and those of the lowland boreal forest east of the Cordillera. The foothills of west-central Alberta may represent a transition

zone. Caribou studied by the Alberta Fish and Wildlife Division in that area exhibited two patterns of habitat use: some animals remained in the boreal, foothills habitat year-round, and others migrated between winter ranges in the foothills and summer ranges in the mountains of British Columbia (Edmonds and Bloomfield 1981). Both types relied primarily on terrestrial forage in their winter ranges in the foothills (J. Edmonds, pers. comm.).

Other ecotypic differences may become apparent as more information is collected. Within the type that depends on terrestrial vegetation in winter, a north-south distinction may be appropriate, but we do not know where the line should be drawn. Hatler (1983) felt that Spatsizi caribou had closer affinities to the north than to the south. On the basis of habitat alone, the environmental differences between the BWBS-SWB-AT complex of biogeoclimatic zones (as in the Spatsizi) and the SBS-ESSF-AT complex (as in the Itchas and Ilgachuz) are great enough to suggest ecotypic differences in the caribou that have adapted to them. This question cannot be resolved without more ecological information about caribou from a variety of locations, most of which are outside our study area.

Ecotypic distinctions imply major differences in the animals' environment and in how they relate to it. Insofar as the differences are known, they should be taken into consideration by researchers when study areas are selected and research findings are extrapolated to other areas. For managers, they imply outside limits to zones within which animals may be expected to respond uniformly to management practices. At present, ecotypic differences among caribou in British Columbia are poorly known. We can improve our understanding of ecotypes by monitoring the results of management as well as by conducting research.

Minor environmental differences may also influence the response of caribou to management practices. For example, wildlife managers in southeastern British Columbia have noted topographic differences between caribou habitat in the Kootenay region and in the North Thompson area which seem to warrant a different emphasis in management. In the Kootenays, the transitional area between closed-canopy and subalpine parkland forest, which is favoured by caribou as winter range, is usually located on sidehills and is relatively narrow. Habitat protection staff generally try to protect this transitional area from logging. In the closed-canopy forest immediately below it they may

recommend selective logging, in an attempt to improve lichen production by opening the stand (G. Woods, pers. comm.). In the North Thompson area, the transitional zone is much greater in extent, and is usually located on plateaus. Extensive logging has occurred below the plateaus. Protection of winter ranges is focussed on those semi-open stands, which managers believe would not benefit from selective logging (S. Macdonald, pers. comm.). Topographic differences have led to a greater emphasis on selective logging in the Kootenays than in the North Thompson area. Differences such as that might best be handled by delimiting management zones -- areas within which the caribou and the habitat are similar enough that management practices may be expected to produce similar results.

Managers need information that will help them determine the geographic area in which a particular management strategy is appropriate, and may be expected to produce uniform results. This information comes both from research and from monitoring management results. Appropriate application of management practices can be improved through recognition of ecotypes and, in some cases, of management zones for caribou.

5.2 Ecological Theory and the Design of Special Management Areas

Principles of island biogeography and related ecological theory have been applied to the design of nature reserves. Here we apply those concepts, not necessarily to reserves, but to the selection of areas where caribou management will be designated a high priority.

A number of general recommendations have been derived from biogeographical theory, and are often repeated: Reserves should be large rather than small, circular rather than elongate, and continuous rather than fragmented; if fragmented, they should be close rather than distant, clumped rather than arranged linearly, and preferably, connected by dispersal corridors (Bunnell 1978; Pickett and Thompson 1978). General principles such as those should be applied cautiously to single-species management areas. First, those recommendations were derived from studies of species diversity, and their applicability to the extinction probability of a particular species is limited. Second, as Higgs (1981) and Simberloff (1983) have pointed out, some often-repeated recommendations do not unequivocally follow from island biogeographical theory -- a single large reserve is not necessarily better

than two half-sized reserves. Finally, general principles are no substitute for knowledge of the species and the habitat values of the proposed management areas.

Bunnell (1978) discussed the application of the above principles to the management of small populations of cervids. Since the areas of reserves will always be determined by political compromise, the minimal request should be the area beyond which further acquisition of land would lead to diminishing returns for the species in question. Because the shape and magnitude of the extinction curve (the relationship between probability of extinction and reserve area) for caribou is unknown, this directive is of limited value in determining reserve size. However, a large continuous reserve is not always the best strategy, especially where preservation of a particular species, rather than an assemblage of species, is foremost. Species rarely become extinct simultaneously in every part of their range. If the reserves are close enough that recolonization is possible, and if disease is not considered to threaten the species with extinction, then two or more smaller reserves may be more effective than one large one. This may be feasible in the case of caribou.

Pickett and Thompson (1978) argued that internal patch dynamics, as well as island biogeographic theory, should be considered in the design of nature reserves. On true islands, species number reaches an equilibrium that is determined by island area and by degree of isolation from continental sources of colonizers. In that context, as nature reserves become increasingly isolated by expanses of culturally modified habitat, colonization sources become less and less available. Internal habitat patches, instead, must function as sources of recolonization. The design of nature reserves requires knowledge of patch dynamics -- the nature, frequency, and size of disturbances, and the associated patterns of succession. Reserve design should be based on an analysis of "minimum dynamic area": the smallest area with a natural disturbance regime which maintains internal recolonization sources, and hence minimizes extinction.

The recommendations of Pickett and Thompson (1978), when applied to caribou, imply that very large management areas are required. They must be considerably larger than the largest disturbance patch size, including rare patches, and must include internal recolonization sources. Fires, the major

natural source of disturbance in caribou range, can be very large: a 1961 fire southeast of Prince George, for example, burned approximately 180 km². Home ranges of caribou reported in the study area ranged from 151 km² to 978 km² (Simpson et al. 1984b). Although the minimum dynamic areas must be determined by local conditions, it is clear that they will be very large.

Wilcox (1980) discussed situations, such as that of the caribou, in which minimum dynamic areas are excessive in relation to other demands for land use. He proposed that in those cases, multiple reserves be manipulated as "artificial archipelagos" in order to minimize the chances of simultaneous extinction in each reserve.

When local catastrophes occur, when natural recolonization fails, or when vacant habitat exists in a key area, managers may wish to consider a relocation program. Research questions related to the development of transplant methods are discussed in Section 6.2.3. Habitat management and relocation programs should be directed toward creating a situation in which repeated intervention is unnecessary.

The literature on design of nature reserves, applied to the situation of caribou in British Columbia, suggests that more than one option is possible: 1) a very large management area, much larger in area than any wildfire, and including internal recolonization sources, or 2) a system of multiple management areas, each large enough to meet the needs of a viable population of caribou, located in an arrangement that allows intercolonization. Relocation of animals, with the goal of creating self-perpetuating populations, is a tool that managers may choose to employ.

5.3 Selecting Priority Areas for Caribou Management

There are no easy solutions to the problem of managing industrial activity and caribou production on the same land base. Our present level of knowledge does not allow us to eliminate either human activity or habitat alteration as causes of declines of caribou populations in the study area. A prudent strategy for caribou management requires that managers try to protect populations from these influences in some areas. Because the costs of conservative management are high, it is important to concentrate efforts in those areas where they are most likely to be successful. If some areas are to be managed with stringent constraints, then other areas must be managed with

few or no constraints. At present, wildlife managers lack guidelines to assist them in placing priorities on geographic areas to be managed for caribou production. The development of such guidelines would require planning at a provincial, rather than a regional level. Here, we propose a framework which we think can help managers select areas for various levels of caribou management. We also use the framework for guidance in the selection of study areas for research (Section 6.3).

5.3.1 A framework for management analysis

We used a 5-step approach to the selection of areas for various levels of caribou management:

1. We divided the study area into geographic units.
2. We rated each geographic unit according to a set of specific factors that are relevant to management (e.g. caribou numbers, impact of logging, consumptive use of caribou).
3. We rated each geographic unit according to a set of overall factors that are relevant to management (e.g. biological viability, degree of habitat disturbance, public use and interest).
4. We prepared a set of map overlays showing the ratings of the overall factors.
5. We used the resulting combinations of map overlays as a basis for recommendations regarding management priorities.

For consistency, and for compatibility with management, we chose to use administrative boundaries for our geographic areas. We selected GMU's (Fig. 3) as our basic units, and grouped them where it was convenient to do so. We recognize that the boundaries of actual management areas identified through this process will need refinement.

We developed a list of specific factors to be rated for each geographic unit. The specific factors and the associated criteria for ratings are given

in Table 16. Some of the specific factors can affect research and management decisions in a variety of ways. For example, a well-developed road system affects management by limiting the manager's ability to control disturbance, and affects research by reducing travel costs. Most of the specific factors are used in the criteria for the overall ratings. A few -- Mobility, Ecotype, Biogeoclimatic Zone, Physiographic Region -- are descriptive of the habitat or the manner in which it is used by the animals, and are included to help managers ensure that a variety of types are included in their considerations. We are not sure of the significance of differences in mobility among (and perhaps within) populations, but we feel that managers should be aware of them. They may affect the responses of caribou to habitat changes, such as linear developments, or to management techniques, such as relocation of animals.

We used the specific factors to develop a set of criteria for five overall ratings: biological viability, degree of habitat disturbance, conflicting land use pressures, level of knowledge, and public use and interest (Table 17). Our ratings of biological viability are based on caribou numbers and on degree of isolation, because we have some information about those specific factors for the entire study area. Recruitment and population trend are also relevant to the assessment of biological viability, but our information was too scattered in time and space to be used consistently in determining overall ratings.

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In Table 18, the specific factors and the overall factors are rated for geographic units. The ratings represent our assessment of the situation in each unit, as of 1984. Although we have tried to tie the ratings to specific criteria, we recognize that they are partially subjective. Where relevant, we

TABLE 16. Management analysis: criteria for specific ratings

Reliability

- A - Judgment based on substantial evidence
- B - Judgment partially supported by evidence
- C - Guess

Numbers

- 1 - < 35
- 2 - 36-99
- 3 - 100-299
- 4 - > 300

Recruitment

- 0 - No information
- 1 - < 10%
- 2 - 10 - 15%
- 3 - > 15%

Population trend

- 0 - No information
- 1 - Declining
- 2 - Stable
- 3 - Increasing

Degree of isolation

- 1 - No contact likely
- 2 - Intermittent contact likely
- 3 - Regular contact likely

Mobility

- 0 - No information
- 1 - Summer and winter ranges geographically separate
- 2 - Summer and winter ranges in the same area

Ecotype

- M - Mountain
- N - Northern

Biogeoclimatic Zones (Pojar 1983)

- AT - Alpine Tundra
- BWBS - Boreal White and Black Spruce
- ESSF - Engelmann Spruce - Subalpine Fir
- ICH - Interior Cedar - Hemlock
- IDF - Interior Douglas-fir
- MS - Montane Spruce
- SBS - Sub-Boreal Spruce

TABLE 16. Continued

Physiographic regions (Holland 1964)

- IP - Interior Plateau
- SRM - Southern Rocky Mountains
- CM - Columbia Mountains
- NRM - Northern Rocky Mountains
- CPM - Central Plateau and Mountain Area
- AP - Alberta Plateau

Impact of logging (excluding access)

- 0 - No impact
- 1 - Logging peripheral to caribou ranges, or only a small proportion of the area has been affected
- 2 - Logging has affected at least one important habitat type or geographic area used by caribou
- 3 - Logging widespread within caribou ranges

Impact of insect attack

- 0 - No epidemic insect attack
- 1 - Insect attack is minor or is not affecting forest harvesting in areas used by caribou
- 2 - Moderate or sporadic insect attack affecting forest harvesting in areas used by caribou
- 3 - Severe and widespread insect attack affecting forest harvesting in areas used by caribou

Impact of fire (since 1940, except where earlier fires are discussed in text)

- 0 - No known fires
- 1 - Fires peripheral to caribou ranges, or only a small proportion of the area used by caribou is in early seral stages (up to pole-sapling) because of fire
- 2 - Fires have affected at least one important habitat type or geographic area used by caribou
- 3 - Widespread fires have resulted in large areas within caribou ranges in an early seral stage (up to pole-sapling)

Access development

- 1 - Access only by trails, lakes, rivers, or air
- 2 - Portions of caribou ranges accessible by road
- 3 - Well-developed road systems, or roads into the alpine, provide access to large areas of caribou range

Other developments

- R - Reservoir
- HS - Permanent human settlement
- P - Oil and gas exploration and/or extraction
- M - Mineral extraction
- RR - Railroad
- HW - Highway
- REC - Recreation (e.g. snowmobiling, skiing)

TABLE 16. Continued

- 0 - No development
- 1 - Development peripheral to known caribou ranges
- 2 - Development affecting at least some of population
- 3 - Development affecting large proportion of population

Public interest in caribou

- 1 - Average level of public interest
- 2 - Special interest at local or regional level (due to visibility, media coverage, interpretive programs)
- 3 - Special interest at provincial or higher level

Consumptive use

- 0 - No legal hunting
- 1 - Legal kill 0-2 caribou/year
- 2 - Legal kill 2-10 caribou/year
- 3 - Legal kill > 11 caribou/year

Pressure on timber supply. (The TSA is included for reference purposes. See Table 1 and Forest Management Planning sections.)

- 0 - Local circumstances allow considerable flexibility
- 1 - No special long-term or short-term supply problems
- 2 - Long-term supply problems: Long Run Sustained Yield 80% or less of current AAC
- 3 - Short-term supply problems: 20-year supply inadequate, and no local mitigating factors

Resource developments planned

- R - Reservoir
- HS - Permanent human settlement
- P - Oil and gas exploration and/or extraction
- M - Mineral extraction
- RR - Railroad
- HW - Highway or major new access
- REC - Recreation

- 0 - No development
- 1 - Development peripheral to known caribou ranges
- 2 - Development potentially affecting at least some of population
- 3 - Development potentially affecting most of population

- X - Development underway
- Y - Development planned
- Z - Development under consideration

TABLE 16. Concluded

Research

- 0 - No studies
- 1 - Short-term or single-faceted studies, or studies that are primarily compilations of existing information
- 2 - Radiotelemetry studies of one year or more, or other field studies adequate to provide information on several aspects of caribou biology

Inventory

- 1 - Incidental observations only
 - 2 - Sporadic and/or few inventory flights
 - 3 - Regular and/or frequent inventory flights
-

TABLE 17. Management analysis: criteria for overall ratings

Biological viability

- A - Centre of large population (500+) with opportunities for regular contact with neighbouring groups
- B - Centre of moderately large population (250-500) with opportunities for regular contact with neighbouring groups
- C - Centre of moderately small population (50-250) with opportunities for regular contact with neighbouring groups
- D - Peripheral or poorly known
- E - Centre of small population (or 0-50) with little opportunity for contact with neighbouring groups

Degree of habitat disturbance

- H - Impact of logging, fire, access, or other developments high (generally, one or more ratings of 3A or 3B)
- M - Impact of logging, fire, access, or other developments moderate (generally, more than one rating of 2A or 2B)
- L - Impact of logging, fire, access, or other developments low or unknown (most ratings 1, or reliability C)

Conflicting land use pressures

- V - Very high; pressure on timber supply rated 3 or planned resource developments expected to have a high impact (usually rated 3X or 3Y)
- H - High; pressure on timber supply rated 2 or insect attack rated 3 or planned resource developments expected to have a moderate impact (usually rated 2X or 2Y)
- M - Moderate; pressure on timber supply rated 0 or 1 and planned resource developments expected to have a low impact (usually 1X or 1Y or Z)
- P - Provincial park

Level of knowledge

- M - Moderate; research rated 2 or inventory rated 3
- L - Low; research rated 1 or inventory rated 2
- N - Nil; research rated 0 and inventory rated 1

Public use and interest

- H - High; public interest or consumptive use rated 3
- M - Moderate; public interest rated 2 or consumptive use rated 1 or 2
- L - Low; public interest rated 1 and consumptive use rated 0

TABLE 18. Management analysis framework

Management considerations	3-35, 36	Game Management Units 3-37, 41, 42	3-40
<u>Specific ratings</u>			
<u>Biological considerations</u>			
Numbers	2B	1B	1B
Recruitment	0	0	0
Population trend	0	0	0
Degree of isolation	3B	3B	3A
Mobility	0	1B	1B
Habitat considerations			
Ecotype	M	M	M
Biogeoclimatic zones	ICH, ESSF, AT	ICH, ESSF, AT	ICH, ESSF, AT
Physiographic region	CM	1P, CM	1P
Impact of logging	3B	3A	3A
Impact of insect attack	1B	2B	1B
Impact of fire	2B	3B	3A
Access development	3B	3A	3A
Other developments	0	HS-1B, RR-2C, HW-2C	HS-1B, RR-2C, HW-2C, REC-3B
Social and economic considerations			
Public interest in caribou	1	1	2
Consumptive use	0	0	0
Pressure on timber supply-TSA	1	1	1
Resource developments planned	Okanagan	Kamloops	Kamloops
Level of knowledge	0	0	0
Research	0	2	2
Inventory	1	2	3
<u>Overall ratings</u>			
Degree of habitat disturbance	H	H	H
Public use and interest	L	L	M
Conflicting land use pressure	M	M	M
Level of knowledge	N	M	M

TABLE 18. Continued

Management considerations	Game Management Units	
	3-43	3-44
<u>Specific ratings</u>		
<u>Biological considerations</u>		
Numbers	1B	2B
Recruitment	0	0
Population trend	0	0
Degree of isolation	3A	3A
Mobility	1B	1B
<u>Habitat considerations</u>		
Ecotype	M	M
Biogeoclimatic zones	ICH,ESSF,AT	ICH,ESSF,AT
Physiographic region	CM	CM,JP
Impact of logging	2C	OA
Impact of insect attack	OB	1A
Impact of fire	1C	3A
Access development	2C	2B
Other developments	HS-1B,RR-3C,HM-3C	HS-1B,RR-3C,HM-3C
Social and economic considerations		REC-2B
Public interest in caribou	1	2
Consumptive use	1	0
Pressure on timber supply-TSA	1	N/A
Resource developments planned	Kamloops	Kamloops
Level of knowledge	0	0
Research	0	2
Inventory	2	3
<u>Overall ratings</u>		
Degree of habitat disturbance	M	M
Public use and interest	M	M
Conflicting land use pressures	M	P
Level of knowledge	L	M

TABLE 18. Continued

Management considerations		Management Units	
		8-23,24; 3-34	4-05,06,20 (southern)
			4-07,08
<u>Specific ratings</u>			
<u>Biological considerations</u>			
Numbers		2B	1A
Recruitment		0	3B
Population trend		0	2B
Degree of isolation		2C	1C
Mobility		2C	2A
<u>Habitat considerations</u>			
Ecotype		M	M
Biogeoclimatic zones		ICH,ESSF,AT	ICH,ESSF,AT
Physiographic region		CM,LP	CM
Impact of logging		2B	3A
Impact of insect attack		3B	3A
Impact of fire		2B	3A
Access development		2B	3A
Other developments		HW-1B,REC-2A	M-1A,HW-3A,REC-2A
Social and economic considerations			
Public interest in caribou		2	3
Consumptive use		0	0
Pressure on timber supply-TSA		1	3
<u>Resource developments planned</u>			
Level of knowledge		0	
Research		0	
Inventory		2	
<u>Overall ratings</u>			
Degree of habitat disturbance		M	H
Public use and interest		M	H
Conflicting land use pressures		H	V
Level of knowledge		L	M

TABLE 18. Continued

Management considerations		Game Management Units			
		4-15, 16, 17, 18, 28, 29, 30, 31, 33	4-19, 20(northern), 26, 27, 34	4-32	
<u>Specific ratings</u>					
<u>Biological considerations</u>					
Numbers		2B	1C	1B	
Recruitment		0	0	0	
Population trend		0	0	0	
Degree of isolation		2C	2C	2C	
Mobility		2C	0	2C	
<u>Habitat considerations</u>					
Ecotype		M	M	M	
Biogeoclimatic zones		ICH,ESSF,AT	ICH,ESSF,AT	ICH,ESSF,AT	
Physiographic region		CM	CM	CM	
Impact of logging		3Ba	1C	2C	
Impact of insect attack		1A	1C	3B	
Impact of fire		2B	2C	1B	
Access development		3Ba	2B	3B	
Other developments		R-2C,HS-2C,M-1C,RR-2C, HW-2C,REC-1C	R-2C,M-1C,REC-2C	R-3C	
<u>Social and economic considerations</u>					
Public interest in caribou		2	1	2	
Consumptive use		0	0	0	
Pressure on timber supply-TSA		3	1	N/AP	
Resource developments planned		Kootenay Lake, Arrow M-2Y	Kootenay Lake, Cranbrook	Revelstoke, Arrow	
Level of knowledge			0	0	
Research		1	0	0	
Inventory		1	1	2	
<u>Overall ratings</u>					
Degree of habitat disturbance		Ha	L	H	
Public use and interest		M	L	M	
Conflicting land use pressures		V	M	H	
Level of knowledge		L	N	L	

TABLE 18. Continued

Management considerations	Game Management Units		
	4-36, 40	4-37, 38	4-39
<u>Specific ratings</u>			
<u>Biological considerations</u>			
Numbers	1C	2B	2B
Recruitment	0	3B	3B
Population trend	0	3B	3B
Degree of isolation	2C	2B	2B
Mobility	0	2B	2B
<u>Habitat considerations</u>			
Ecotype	M	M	M
Biogeoclimatic zones	ICH, ESSF, AT	ICH, ESSF, AT	ICH, ESSF, AT
Physiographic region	SRM	CM	CM
Impact of logging	1C	2B	2B
Impact of insect attack	2C	OA	OA
Impact of fire	2C	2B	2B
Access developments	2C	2B	2B
Other developments	R-3C	R-2C, HW-2C, RR-2C, REC-2C	REC-2C
Social and economic considerations			
Public interest in caribou	1	2	2
Consumptive use	0	1	0
Pressure on timber supply-TSA	2	1C	1C
Resource developments planned	Golden	Revelstoke, Golden	Revelstoke
Level of knowledge	0	R-2X, M-1X	R-3X
Research	0	2	2
Inventory	1	2	2
<u>Overall ratings</u>			
Degree of habitat disturbance	L	M	M
Public use and interest	L	M	M
Conflicting land use pressures	H	H	V
Level of knowledge	N	M	M

TABLE 18. Continued

Management considerations	Game Management Units	
	5-2A, 15A, 15B	5-6, 12
Specific ratings		5-10, 11
Biological considerations		
Numbers	3B	3B
Recruitment	0	3B
Population trend	0	3B
Degree of isolation	3C	3C
Mobility	2B	1B
Habitat considerations		
Ecotype	M	N
Biogeoclimatic zones	ICH, ESSF, AT	SBS, ESSF, AT
Physiographic region	IP, CM	1P
Impact of logging	3Ad	2B
Impact of insect attack	2Ad	1A
Impact of fire	3B	1B
Access development	3Bd	1B
Other developments	M-2B, REC-2B	REC-2B
Social and economic considerations		
Public interest in caribou	1	2
Consumptive use	2	3
Pressure on timber supply-TSA	1	1
Resource developments planned	Williams Lake, Quesnel, 100 Mile House	Williams Lake, Quesnel
Level of knowledge	0	P-2X, HW-2Z
Research	2	2
Inventory	2	3
Overall ratings		
Degree of habitat disturbance	H	L
Public use and interest	M	M
Conflicting land use pressures	M	P
Level of knowledge	M	M

TABLE 18. Continued

Management considerations	Game Management Units		
	5-16	6-1,2(eastern),4;7-12	6-2(western)
<u>Specific ratings</u>			
<u>Biological considerations</u>			
Numbers	1B	4A	4B
Recruitment	0	3B	3B
Population trend	0	3B	3B
Degree of isolation	2B	3C	3C
Mobility	0	1C	1C
<u>Habitat considerations</u>			
Ecotype	M	N	N
Biogeoclimatic zones	ICH,ESSF,AT	SBS,ESSF,AT	SBS,ESSF,AT
Physiographic region	1P,OM	1P	1P
Impact of logging	OA	1B	OA
Impact of insect attack	1A	3A	1A
Impact of fire	1B	3A	3A
Access developments	1A	2A	1A
Other developments	REC-2B	R-3C,HS-2C,M-1B	REC-2B
Social and economic considerations			
Public interest in caribou	2	1	2
Consumptive use	0	1	0
Pressure on timber supply-TSA	N/A	3	N/A
Resource developments planned		Lakes, Morice	
Level of knowledge	0	0	0
Research	0	2	2
Inventory	1	2	2
<u>Overall ratings</u>			
Degree of habitat disturbance	L	M	L
Public use and interest	M	M	M
Conflicting land use pressures	P	V	P
Level of knowledge	N	M	M

TABLE 18. Continued

Management considerations	Game Management Units		
	6-9	7-1	7-2
<u>Specific ratings</u>			
<u>Biological considerations</u>			
Numbers	2B	2C	2C
Recruitment	3B	0	0
Population trend	3B	0	0
Degree of isolation	2C	3C	3C
Mobility	2C	1C	1C
<u>Habitat considerations</u>			
Ecotype	N	M	M
Biogeoclimatic zones	SBS,ESSF,AT	SBS,ICH,ESSF,AT	SBS,ICH,ESSF,AT
Physiographic region	CPM,LP	SRM	SRM,CM
Impact of logging	1B	1C	1C
Impact of insect attack	2A	1A	1A
Impact of fire	1A	1C	1C
Access developments	3A	1A	2C
Other developments	HS-3C,RR-3C,HW-3C, M-1A,REC-3A	RR-2C,HW-2C,REC-3C	R-3C,RR-1B,HW-1B
<u>Social and economic considerations</u>			
Public interest in caribou	2	2	1
Consumptive use	0	0	0
Pressure on timber supply-TSA	2e	N/A	1
Resource developments planned	Morice, Bulkley M-2Z,R-1Z	0	McBride 0
Level of knowledge			
Research	2	0	0
Inventory	3	2	1
<u>Overall ratings</u>			
Degree of habitat disturbance	H	L	L
Public use and interest	M	M	L
Conflicting land use pressures	H	P	M
Level of knowledge	M	L	N

TABLE 18. Continued

Management considerations	Game Management Units	
	7-3	7-4
Specific ratings		
Biological considerations		
Numbers	2B	1C
Recruitment	0	0
Population trend	0	0
Degree of isolation	3B	3C
Mobility	1A	0
Habitat considerations		
Ecotype	M	M
Biogeoclimatic zones	SBS, ICH, ESSF, AT	SBS, ICH, ESSF, AT
Physiographic region	SRM	CM
Impact of logging	2C	2C
Impact of insect attack	1B	0A
Impact of fire	2B	2C
Access development	2B	3C
Other developments	HS-2C, RR-2B, HW-2B,	HS-2C, RR-2C, HW-2C
		HS-2A, RR-2B, HW-2A, REC-2A
Social and economic considerations		
Public interest in caribou	1	1
Consumptive use	0	0
Pressure on timber supply-TSA	1	1
	McBride	McBride
	0	0
Resource developments planned		
Level of knowledge		
Research	0	0
Inventory	2	2
		McBride, Prince George
Overall ratings		
Degree of habitat disturbance	M	M
Public use and interest	L	M
Conflicting land use pressures	M	H
Level of knowledge	L	M

TABLE 18. Continued

Management considerations	Game Management Units		
	7-6	7-7	7-8,9
Specific ratings			
Biological considerations			
Numbers	2B	2B	1B
Recruitment	0	0	0
Population trend	0	0	1
Degree of isolation	3B	3B	2B
Mobility	2B	2B	2B
Habitat considerations			
Ecotype	M	M	M
Biogeoclimatic zones	SBS, ICH, ESSF, AT	SBS, ICH, ESSF, AT	SBS, ICH, ESSF, AT
Physiographic region	IP, OM	IP	IP
Impact of logging	2B	2B	3B
Impact of insect attack	3B	3B	3B
Impact of fire	2B	3C	3B
Access development	2B	2B	3A
Other developments	0	RR-1B, HW-1B, REC-2B	HS-2B, RR-1C, HW-1C, REC-3B
Social and economic considerations			
Public interest in caribou	1	2	1
Consumptive use	0	0	0
Pressure on timber supply-TSA	1	1	1
Resource developments planned	Prince George	Prince George	Prince George
Level of knowledge	0	M-1Z	0
Research	0	2	1
Inventory	1	2	2
Overall ratings			
Degree of habitat disturbance	M	M	H
Public use and interest	L	M	L
Conflicting land use pressures	H	H	H
Level of knowledge	L	M	L

TABLE 18. Continued

Management considerations	Game Management Units		
	7-16	7-17	7-18
Specific ratings			
Biological considerations			
Numbers	1C	2B	2B
Recruitment	0	0	0
Population trend	0	0	0
Degree of isolation	3B	3B	3B
Mobility	0	2B	2C
Habitat considerations			
Ecotype	M	M	M
Biogeoclimatic zones	SBS, ESSF, AT	SBS, ICH, ESSF, AT	SBS, ICH, ESSF, AT
Physiographic region	IP	IP, SRM	NRM, SRM
Impact of logging	2C	3B	2B
Impact of insect attack	2C	2B	3B9
Impact of fire	1B	1B	2A
Access development	2B	3A	2A
Other developments	0	HS-2C, RR-2A, REC-2B	0
Social and economic considerations			
Public interest in caribou	1	2	1
Consumptive use	0	0	0
Pressure on timber supply-TSA	1C	1C	1
Resource developments planned	Prince George	Prince George	Prince George
Level of knowledge	0	R-2Z	HW-3X, R-2Z
Research	0	1	1
Inventory	2	2	2
Overall ratings			
Degree of habitat disturbance	M	H	M
Public use and interest	L	M	L
Conflicting land use pressures	M	M	H
Level of knowledge	L	L	L

TABLE 12. Continued

Management considerations	Game Management Units		
	7-19	7-20	7-21
Specific ratings			
Biological considerations			
Numbers	2B	1B	2B
Recruitment	0	0	0
Population trend	0	0	0
Degree of isolation	3B	3C	3C
Mobility	1B	1B	1C
Habitat considerations			
Ecotype	N	N	N
Biogeoclimatic zones	BMBS, ESSF, AT	BMBS	BMBS, ESSF, AT
Physiographic region	NRM	AP	NRM
Impact of logging	OA	1C	1B
Impact of insect attack	OA	OA	1A
Impact of fire	1C	2B	2B
Access developments	2B	3B	2B
Other developments	P-2C, M-2C	P-3C	P-3B, M-2A
Social and economic considerations			
Public interest in caribou	1	1	1
Consumptive use	1	0	1
Pressure on timber supply-TSA	0h	1	1
Resource developments planned	Peace	Peace	Peace
Level of knowledge	M-3Y	0	HS-2X, M-3X, RR-2X
Research	0	2	2
Inventory	2	2	2
Overall ratings			
Degree of habitat disturbance	L	M	M
Public use and interest	M	L	M
Conflicting land use pressures	V	M	V
Level of knowledge	L	M	M

TABLE 18. Concluded

Management considerations	Game Management Units	
	7-22	7-23
<u>Specific ratings</u>		
<u>Biological considerations</u>		
Numbers	2B	2B
Recruitment	0	0
Population trend	0	0
Degree of isolation	3B	3B
Mobility	0	0
<u>Habitat considerations</u>		
Ecotype	N	M
Biogeoclimatic zones	BWBS,ESSF,AT	SBS,ESSF,AT
Physiographic region	NRM	NRM
Impact of logging	2B	2C
Impact of insect attack	0A	2C
Impact of fire	1B	1C
Access development	2B	2B
Other developments	P-2C,M-2B	RR-2C,R-2C
<u>Social and economic considerations</u>		
Public interest in caribou	1	1
Consumptive use	1	0
Pressure on timber supply-TSA	1	1
	Peace	Prince George
Resource developments planned	M-2X,RR-1X	RR-2X
<u>Level of knowledge</u>		
Research	0	0
Inventory	2	2
<u>Overall ratings</u>		
Degree of habitat disturbance	M	M
Public use and interest	M	L
Conflicting land use pressures	H	M
Level of knowledge	L	L

^aExcept GMU 4-33.

^bCaribou habitat in this unit is located entirely within TFL's.

^cExcluding TFL's.

^dExcept for undeveloped blocks along eastern boundary.

^eExcept in Bulkley TSA.

^fExcluding research based in Alberta.

^gSome severely attacked areas are too remote to be harvested economically.

^hFlexibility is high because area is undeveloped.

have rated the reliability of our assessments. Reliability ratings of habitat factors take into account both our knowledge of the factor and our knowledge of caribou habitat; a development may be rated "C" because we are unsure of its geographic extent, unsure of its impact on caribou, or unsure of the geographic range of caribou in that unit. We consider the framework itself to be more important than the ratings, which must be reassessed whenever the framework is applied.

In Table 18, all specific ratings and all overall ratings except biological viability are organized by GMU's or groups of GMU's. The ratings apply only to those portions of the GMU's lying within the broad range of caribou (Fig. 1). Population estimates for GMU's are those discussed or listed in the population sections of Chapter 2. Where local populations overlapped unit boundaries, some or all of the animals involved were considered referable to each. For that reason, the unit-by-unit results in Table 18 are not additive.

In the case of our ratings of biological viability, we found it necessary to identify geographic areas that did not correspond to administrative boundaries. We mapped those centres of caribou populations that we were able to identify with the information we had; the boundaries are based on the apparent distribution of the animals. As better information on numbers and distribution becomes available, it is likely that other population centres within the broad range of caribou will be identified. Because the geographic units for the biological viability ratings do not correspond to GMU's the ratings are not given in Table 18. The population centres, classified by their biological viability rating, are shown in Fig. 13.

We produced the following combinations of map overlays:

Biological viability and public use and interest (Fig. 14)

Biological viability and level of knowledge (Fig. 15)

Biological viability and degree of habitat disturbance (Fig. 16)

Biological viability and conflicting land use pressures (Fig. 17)

Biological viability, degree of habitat disturbance, and conflicting land use pressures (Fig. 18)

The map units for biological viability are intended to be natural: they are based on what we know of the distribution and numbers of animals in our study area. In all other cases, the map units are GMU's (Fig. 3) or groups of GMU's. The ratings, which are those given in Table 18, apply only to caribou range within the GMU's, not to the entire GMU's.

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5.3.2 Results

Biological viability (Fig. 13)

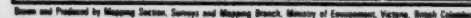
Within the broad range of caribou in the study area, we have mapped those population centres that we were able to identify with the information we have. We are aware of other probable population centres, especially in Regions 4 and 7, but we cannot classify them with the inventory information available.

Of the larger population centres (Types A, B, and C), three belong to the northern ecotype and three to the mountain ecotype.

The two westernmost population centres are isolated from the others in our study area, and perhaps also from populations to the north. Interchange between the two is likely.

In the east, there is a more or less continuous distribution of caribou from north to south, although some local populations, including those mapped as Type E, probably have little opportunity for contact with adjacent groups. The northernmost population in Region 7 is at the southern end of a continuous distribution of caribou of the northern ecotype, most of which are outside our study area.

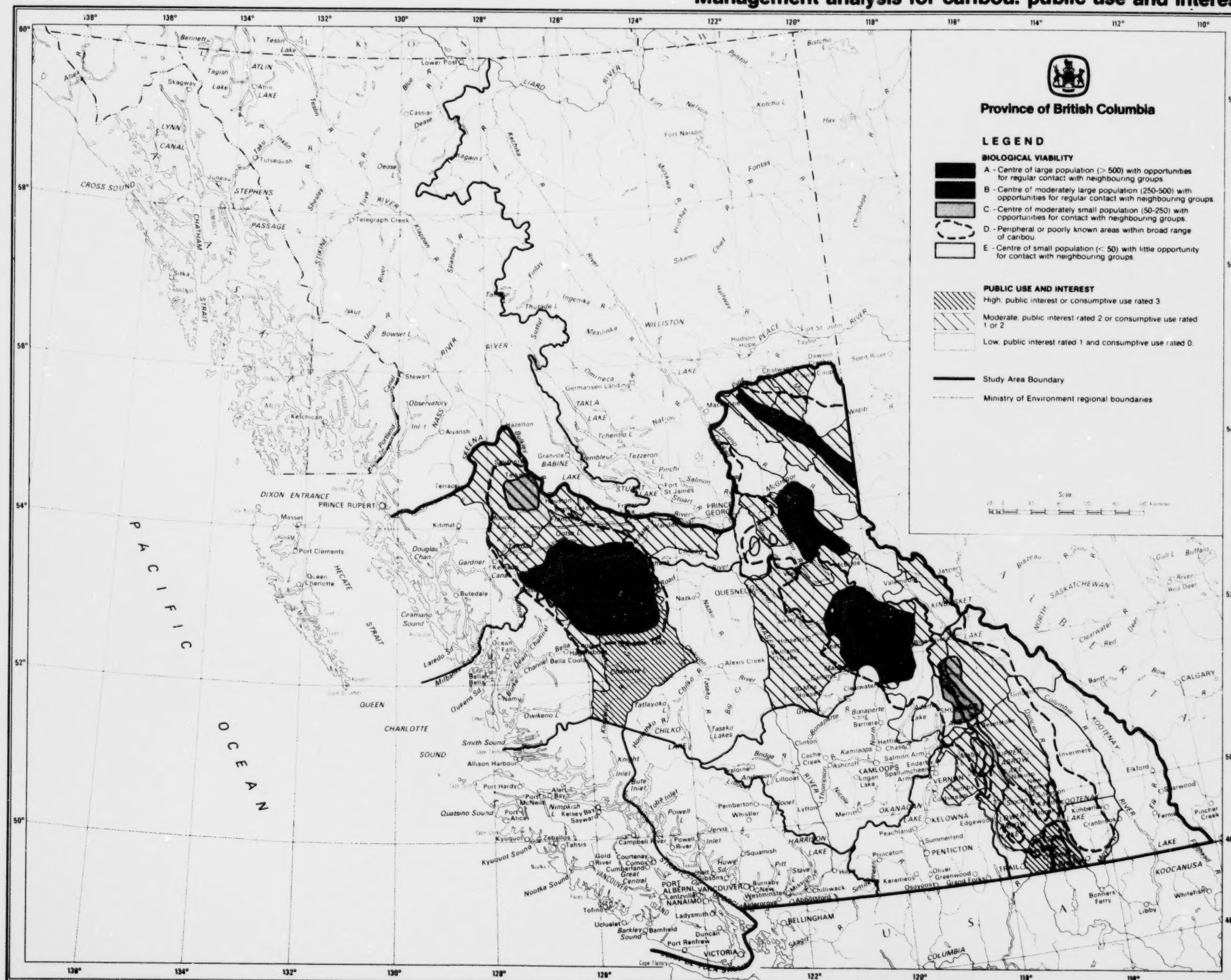
Population centres in Jasper National Park, Willmore Wilderness Park, and the Grande Cache area in Alberta are continuous with caribou range in the study area.



Biological viability and public use and interest (Fig. 14)

Only two areas were rated high in public use and interest: GMU's 5-6 and 5-7 because of the high level of consumptive use, and MU's 4-7 and 4-8 because of the international profile of the Selkirk caribou. Of those two areas, one corresponds to a Type A population centre, and one to a Type E population centre.

Areas rated as moderate either support legal hunting or have attracted public interest because of studies that have received publicity, interpretive programs in parks, or the visibility of the animals themselves. All type B and C population centres are located in areas of moderate public use and interest.



Biological viability and level of knowledge (Fig. 15)

The legend for this map reflects our opinion that nowhere in the study area can level of knowledge be considered high. Areas rated as moderate have been the scene of radiotelemetry studies or other long-term field studies, or have been the subject of frequent inventory attempts, or both. Major information gaps may exist even in those areas. Areas rated as low in knowledge have been the subject of one or more inventory flights, or of short-term studies.

We have included in our rating system the radiotelemetry studies in GMU's 5-10, 5-12, 5-15, 6-1, and 7-20,21 that began after the period of data collection for this report (Appendix 3).

The ratings of moderate for level of knowledge in the single Type A population centre are a result of two factors. First, there have been serious attempts at regular inventory, especially in the Itcha-Ilgachuz ranges and in northern Tweedsmuir Park. Second, radiotelemetry studies have recently been initiated in GMU's 5-10, 5-12, and 6-1. General biological knowledge of the population centre is still low, but information gaps are being addressed.

Of the three Type B population centres, the Wells Gray Park area is best known in terms of both research and inventory. That portion of the Wells Gray population centre located in GMU's 5-2 and 5-15 is the subject of an ongoing radiotelemetry study.

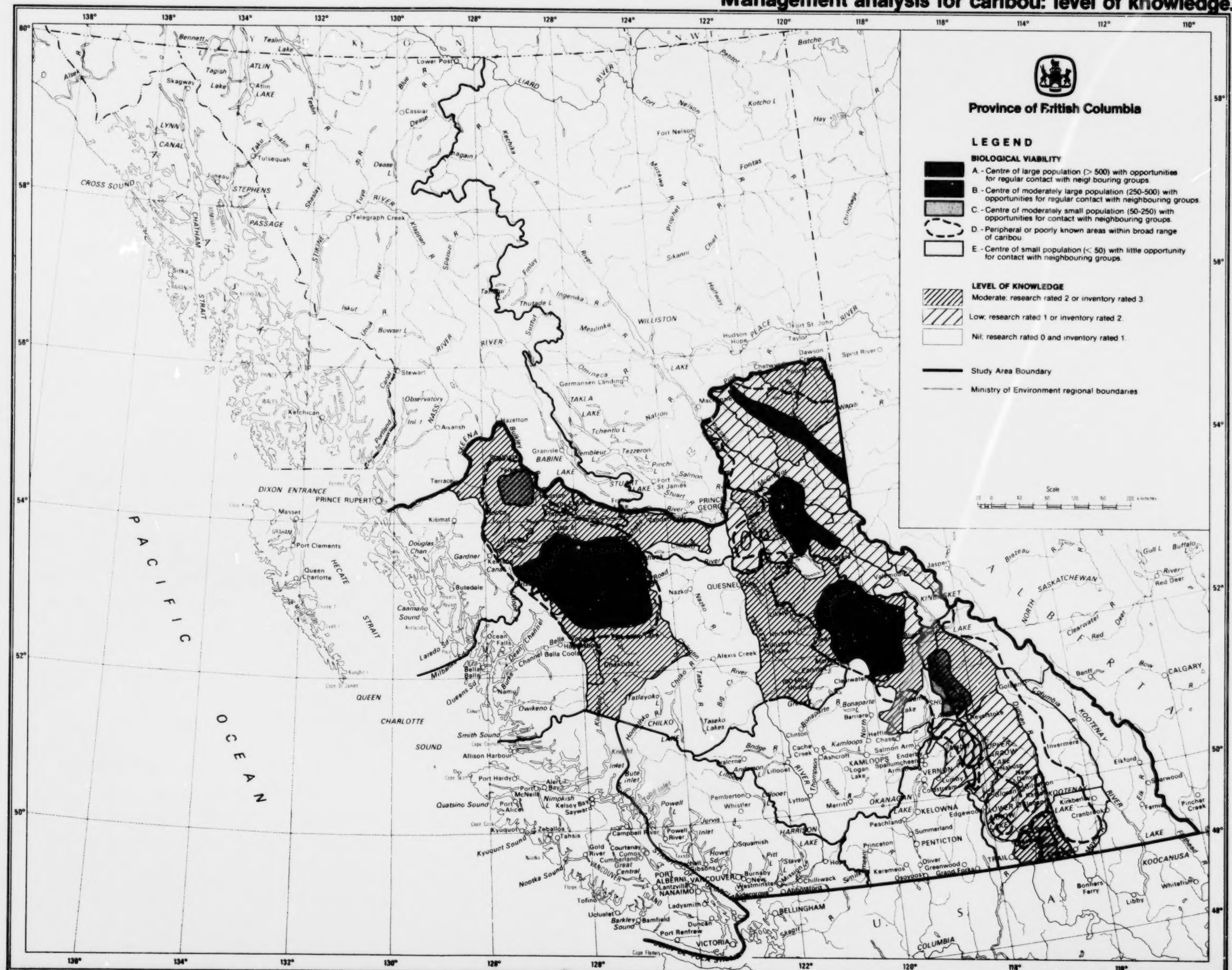
The Type B population centre located east of Prince George appears to be better known than it actually is; the moderate ratings are based on studies conducted without radiotelemetry in a small area straddling the boundary between GMU's 7-5 and 7-7.

The Type B population centre in 7-19, 7-21, and 7-22 is also poorly known, although a radiotelemetry study in 7-21 should help to fill the information gaps.

Both Type C population centres are rated as being moderately well known.

No population centres are located in GMU's rated nil in level of knowledge. It is possible that other population centres exist in other poorly known GMU's.

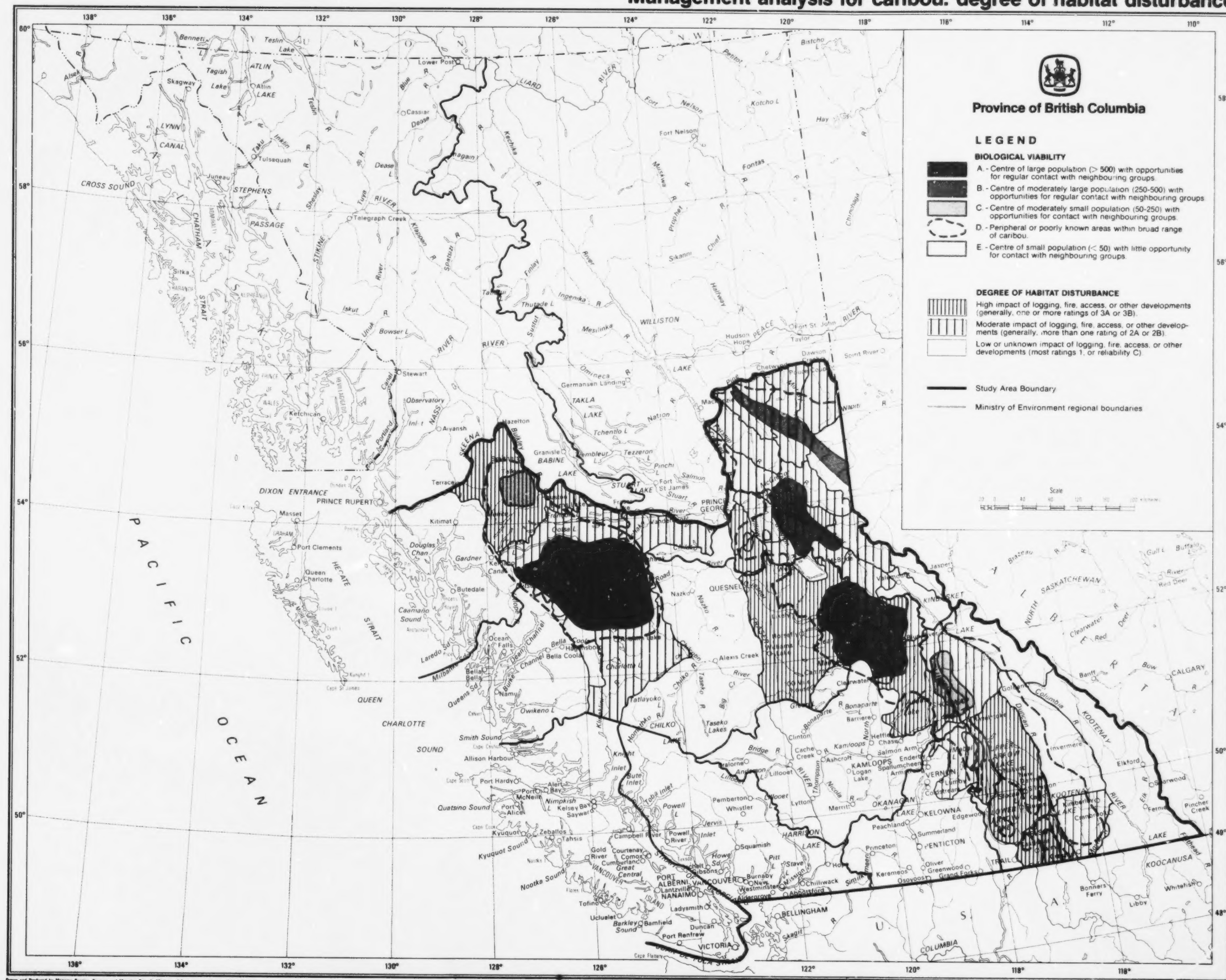
FIGURE 15.
Management analysis for caribou: level of knowledge.



Biological viability and degree of habitat disturbance (Fig. 16)

Most areas that are rated high in habitat disturbance have experienced a high impact from logging and logging-related access. In GMU 6-9, easy access into high elevation caribou ranges was the determining factor. Logging and access were also the primary factors in areas rated as moderate in disturbance. The GMU's 3-45 and 3-46 were rated as moderate because of the effects of fire.

No attempt has been made to distinguish between the impact of a given disturbance factor in different parts of the study area. Logging and fire may be more detrimental to mountain caribou than to northern caribou, but access is postulated to have a negative impact on both ecotypes.



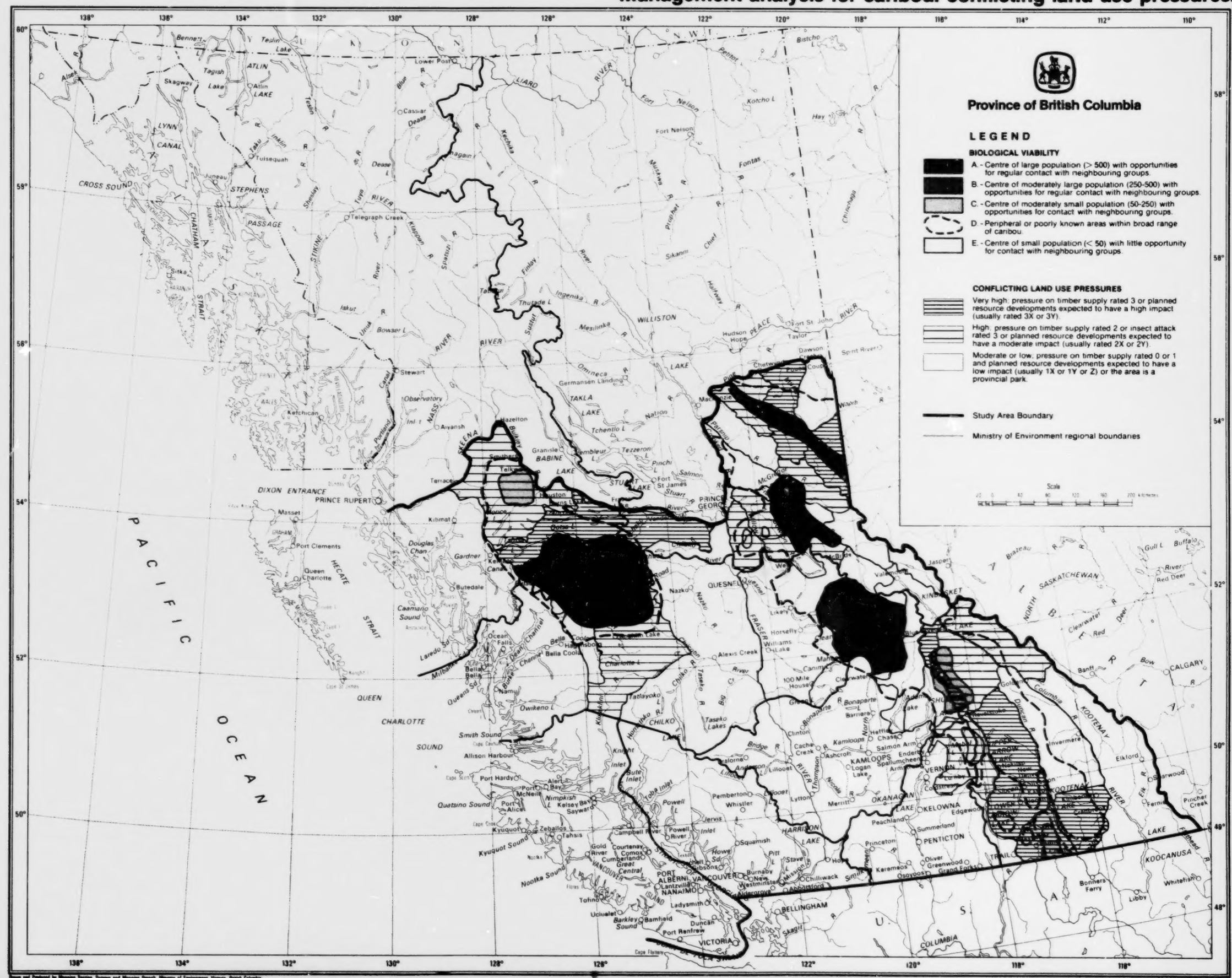
Biological viability and conflicting land use pressures (Fig. 17)

No portions of the study area are free of developments or potential developments that conflict with the needs of caribou. Wood supply problems are ubiquitous and can be locally severe even in areas rated as moderate in conflicting land use pressures. Conversely, local factors can mitigate wood supply problems in areas rated as high or very high in conflicting land use pressure.

The anticipated impact of the Northeast Coal development is high in GMU's 7-19 and 7-21. The very high rating in GMU 4-39 is due to the Revelstoke Dam impoundment. Other very high ratings reflect severe wood supply problems.

Wood supply problems or intensified harvesting due to insect attacks dominate the GMU's rated as high in conflicting land use pressures. The GMU's 5-6 and 5-12 were rated high because of gas and oil exploration and potential development.

Parks are in a class of their own. Although they are not subject to most land use pressures, the impact of recreational activities on caribou is potentially significant.



Biological viability, degree of habitat disturbance and
conflicting land use pressures (Fig. 18)

When existing and anticipated habitat disturbances are viewed in concert, it is apparent that there are few parts of the study area that are free of impacts.

The Type B population centre in the Peace subregion is subject to a high impact from the Northeast Coal development.

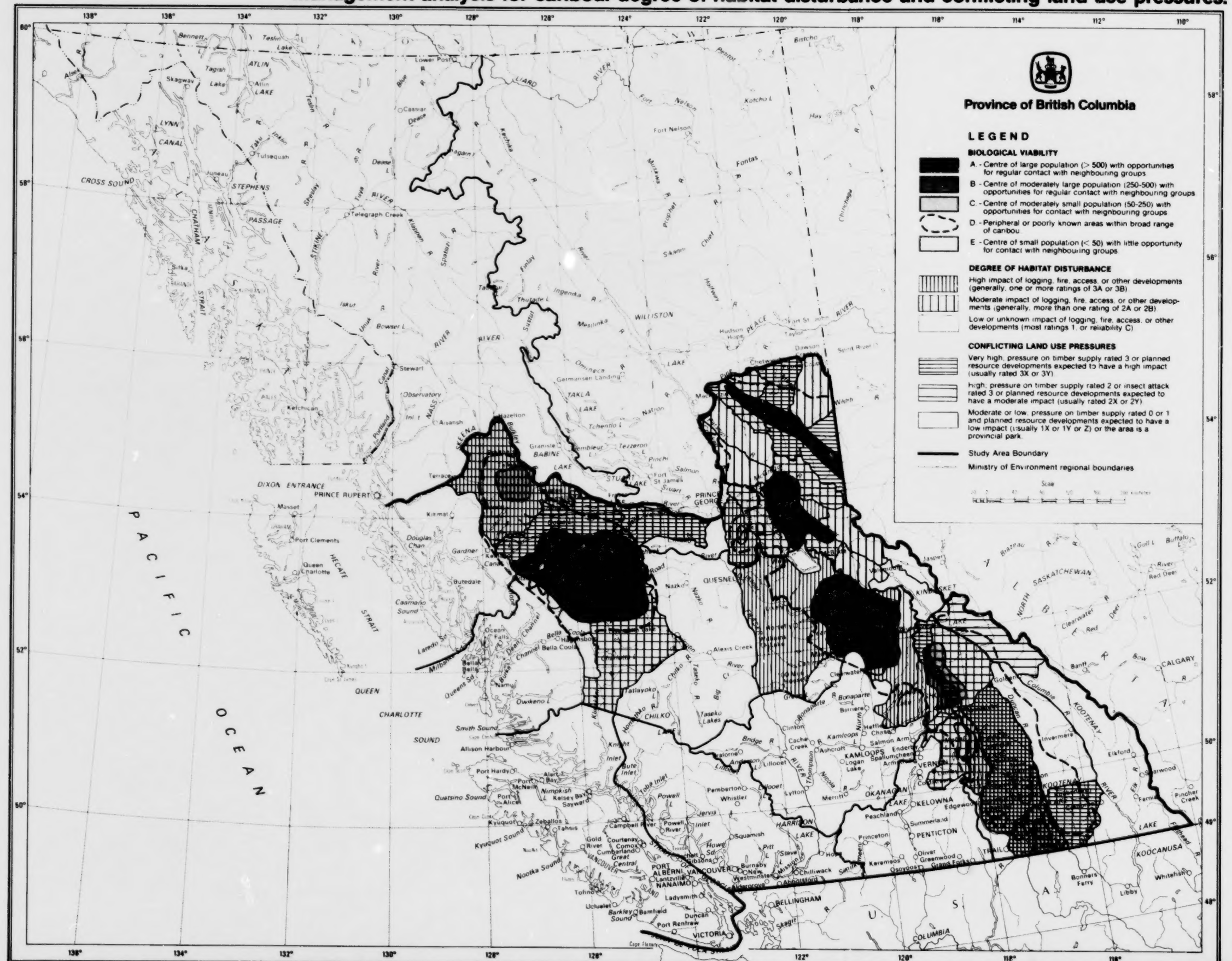
The Type B population centre east of Prince George, which is bisected by a major transportation corridor, has experienced a moderate to high degree of habitat disturbance and is currently subject to intensified logging due to insect attack.

Habitat disturbance in the Wells Gray Park population centre is due mainly to logging and fire. The park itself was assigned a moderate habitat disturbance rating because of extensive fires in the 1920's and 1930's. East of the park, logging has been widespread in caribou ranges. West of the park, that portion of GMU 5-15 lying between the northern and eastern arms of Quesnel Lake is actually undeveloped; the high habitat disturbance rating for that area was generalized from the rest of the unit. Although the Wells Gray Park population centre has been the subject of much controversy between forest and wildlife managers, our ratings indicate that the severity of the pressure on the timber supply in that area, compared to that in other TSA's, is no more than average.

The Type E population centres in the southern Monashee and, especially, the southern Selkirk Mountains stand out as having low levels of biological viability and high levels of land use conflict.

Because of the high level of biological viability in the Tweedsmuir Park area, resolution of land use conflicts is particularly important. The degree of habitat disturbance is rated as moderate outside the park. Land use conflicts in the south are related mainly to petroleum exploration and to harvesting of beetle-killed trees; in the north, to insect infestations and to a serious wood supply shortage east of the park.

FIGURE 18.
Management analysis for caribou: degree of habitat disturbance and conflicting land use pressures.



If management objectives for caribou are to be met in the study area, areas must be ranked for caribou management. For a number of reasons, including the importance of the broad biogeographic context in planning and the fact that caribou population centres overlap regional boundaries, the designation of high priority management areas should be done at a provincial level. We have proposed a framework that can assist this kind of planning. We acknowledge that the specific ratings we have assigned to geographic areas within our framework are subject to change. On the basis of the information available to us, we recommend that the following three areas be designated as high priority caribou management units:

The Tweedsmuir Park population centre (Fig. 13). This population centre, which belongs to the northern ecotype, is characterized by high levels of both biological viability and public use and interest. Existing habitat disturbance is only moderate, but conflicting land use pressures are high in GMU 5-12 and very high in GMU 6-1. Resolution of those conflicts should be a high priority. Interchange between that population centre and the Telkwa population centre is likely; interchange with any other population centres is not likely. The Tweedsmuir Park population centre is significant as it is the southernmost extension of the northern ecotype. Because of the large size of the area and the fact that it apparently includes several of each type of seasonal habitat, it is probably adequate to maintain internal recolonization sources, and is a viable unit for the perpetuation of caribou.

The Wells Gray Park population centre and the population centre east of Prince George (Fig. 13). These two Type B population centres have the highest ratings for biological viability in the range of mountain caribou. A continuous distribution of animals, and therefore the possibility of genetic interchange and recolonization, exists among these two centres and populations in adjacent Alberta. Both centres are rated moderate in public use and interest. Both centres have moderate or high levels of existing habitat disturbance. Wood supply problems in the two areas, analyzed at the TSA level, are no greater than average, although accelerated harvesting is taking place in parts of GMU's 7-5, 7-6, and 7-18 because of spruce beetle attacks. Because of the moderate size of the two areas and the degree of habitat

disturbance already sustained, we feel that it is necessary to designate both areas for high priority management in order to maximize the chances of perpetuating the mountain caribou ecotype.

Considered on the basis of biological viability, we cannot recommend the designation of the southern Selkirks as a high-priority management area. We recognize that management priorities are determined by social and political considerations as well as biological ones, and that the high political profile of the Selkirk caribou may warrant a special status for the area.

We do not feel that we can make any recommendations concerning the Type B population centre located in the Peace subregion. This population centre is the southernmost extension of a continuous distribution of caribou of the northern ecotype, most of which are located outside our study area. The importance of the Peace population centre should be evaluated in that context.

Because of the uncertainty surrounding the effects of human activities on caribou, management constraints must be restrictive in key caribou ranges within high-priority management areas. Key caribou ranges must be identified. The maps in Volume 2, coupled with the experience of regional wildlife and habitat biologists, provide a basis for initial identification of key caribou ranges. We recommend the following constraints on key caribou ranges in high-priority management areas for mountain caribou: 1) no industrial development or 2) access control, partial cutting, and extended rotation (Chapter 3). For northern caribou, we recommend 1) no industrial development or 2) access control and restriction of logging to areas peripheral to key ranges. Because of the lack of information on the basic ecology of northern caribou, we are unable to make more specific recommendations regarding logging. An ongoing inventory program should be instituted for high-priority management areas. Designations of key caribou ranges and management constraints may be modified as more information becomes available.

We have not recommended specific areas for management on a medium priority basis. Since medium-priority population centres are not as important in a provincial context as the high-priority population centres we have identified, we feel that they should be selected at a regional level. Provincial context should be one factor considered by regional managers in selecting medium-priority management areas. Potentially, medium-priority management

areas can both enhance the viability of nearby high-priority management areas, and be enhanced by them.

We are also unable to recommend specific management prescriptions for medium-priority management areas, because of the uncertainty surrounding the impact of various management techniques. Our recommendation is that managers select a strategy, such as minimizing the impact of access or attempting to maintain arboreal lichen production, apply it consistently in a given area, and monitor the results. Caribou populations in medium-priority management areas should be inventoried regularly.

To concentrate management effort and co-operation into those areas designated high and medium in priority, wildlife managers must be prepared to manage other areas with few or no constraints due to caribou.

5.4 Management Recommendations

The management objectives of the British Columbia Ministry of Environment for caribou in the study area are to maintain or increase numbers on traditional ranges in the major biophysical zones in which the species naturally occurs. Our recommendations for meeting those objectives are summarized in this section.

Caribou management should be provincially co-ordinated so that regional inventory and research results and management decisions are consistent and comparable. Such a system would reduce or eliminate many of the administration-related management problems identified in Section 4.1, and would lead to a more unified approach to addressing the specific objectives in the provincial management plan for the species.

To reduce the uncertainty associated with past hunting data, an attempt should be made to reprogram those data. Resident and guided hunter results should be incorporated into a system which allows cross-referencing between GMA's, MA's and GMU's (Section 4.2).

In selecting management strategies, managers should consider geographic differences in how caribou relate to their habitat. Ecotypic differences, as between northern and mountain caribou, imply outside limits to zones within

which animals may be expected to respond uniformly to management practices. In some cases, minor environmental differences may also result in geographical variations in the response of caribou to management practices.

Managers should consider the implications of biogeographic principles when placing priorities on geographic areas to be managed for caribou production. Options to be considered include focussing management efforts onto single management areas large enough to include internal recolonization sources, or instituting a system of multiple management areas located in an arrangement that allows intercolonization.

Some areas should be designated in which caribou management is a high priority. Our present level of knowledge does not allow us to eliminate either human activity or habitat alteration as causes of declines of caribou populations in the study area. A prudent strategy for caribou management requires that managers try to protect populations from those influences in some areas. Conservative management efforts should be concentrated in those areas where they are most likely to be successful.

Designation of high-priority caribou management areas should be done at a provincial level. Caribou population centres overlap regional boundaries. The broad biogeographic context is best considered at a provincial rather than regional level. Management constraints applied to high-priority management areas are likely to be accepted better if the areas have been designated at the provincial level.

We recommend the following caribou population centres as high-priority management areas: Tweedsmuir Park and adjacent land to the east; Wells Gray Park and adjacent land to the east and west; parts of the upper Fraser drainage east of Prince George (Fig. 13). We developed a management analysis framework to help managers select areas for high- and medium-priority caribou management. The framework allowed us to consider in a broad geographic context the biological viability of caribou, public use and interest in caribou, level of knowledge about caribou, degree of habitat disturbance, and conflicting land use pressures. Our recommendation concerning the three

caribou population centres described above resulted from the application of the management analysis framework.

Key caribou ranges in high-priority management areas should be identified. Initially, identification of key caribou ranges may be based on the maps in Volume 2, coupled with the experience of regional biologists. Designation of key ranges may be modified as more information becomes available.

Management constraints in key caribou ranges in high-priority management areas should be restrictive. For mountain caribou, we recommend the following constraints on key caribou ranges in high-priority management areas: 1) no industrial development or 2) access control, partial cutting, and extended rotation. For northern caribou, we recommend 1) no industrial development or 2) access control and restriction of logging to areas peripheral to key ranges. Those constraints may be modified as more information becomes available.

Some areas should be designated in which caribou management is of medium priority. Medium-priority management areas should be selected, and management strategies determined, at a regional level.

Caribou populations in high- and medium-priority management areas should be inventoried regularly.

Areas not designated as high or medium in priority for caribou management should be managed without costly constraints due to caribou.

6 RESEARCH NEEDS

The central purpose of this review of the status of caribou and caribou habitat is to identify information needs that are relevant to the design of a research program. In Chapter 2, we identified information gaps that have troubled managers in specific local areas. In Chapter 3, we discussed the dilemma and the information needs of those attempting to manage forests to produce both timber and caribou. Inadequacies in the existing data base that are discussed in Chapter 4 suggest needs for improvements in methods, some of which require research. The information needs we have identified vary in their importance and in their logical priority. To design effective research, program planners need a way of organizing information needs and determining the order in which they should be addressed.

In this chapter, we approach information needs from a broader perspective than we did in previous chapters. Recognizing that our understanding of the factors affecting population levels determines the direction of management and research, we briefly consider aspects of population regulation in caribou. We then develop an a priori research framework to help us consider as many areas of investigation as possible, and to set priorities for research. As the framework is applied, information needs identified in earlier chapters fall into place. We identify a set of broad questions which involve interactions among topics. Finally, we present our recommendations for research topics and some considerations for the selection of study areas.

6.1 Aspects of Population Regulation

A continuing controversy in theoretical ecology has been the question of what "regulates" populations. In the strict sense, as summarized by McNaughton and Wolf (1979:343), "... to be considered regulated, a population must respond either intrinsically or via extrinsic factors to change its growth rates in relation to the ability of its environment to support a particular density". They further observe that "proving regulation requires demonstrating negative feedback from [an] environmental parameter to the population size." The literature on this subject is voluminous, if not conclusive, with individual points of view favouring competition, physical

characteristics of the environment, interspecific phenomena such as predation, physiological failure, behavioural factors, and even genetic changes.

A full review of the subject is clearly beyond the scope of this report, although a brief consideration of factors potentially affecting wild cervids seems warranted in the context of our research framework. It is generally recognized that any or all of the factors listed or implied above may act, singly or in combination, to reduce or limit numbers in any given local population of animals. The central question is whether there are any generalities applicable to particular animals. The factors that most consistently and significantly affect a species are the ones that should receive priority in both research and management deliberations.

A recent compilation of symposium proceedings (Bunnell et al. 1983) includes review papers on regulation of four species of North American cervids. The emerging hypotheses for mule deer (Odocoileus hemionus) (Mackie 1983) and moose (Alces alces) (Peek and Eastman 1983) are similar in that both cast features of habitat as "ultimate" factors, and relegate factors such as predation, disease, and weather to secondary or proximate roles. In the case of the mule deer, habitat diversity is seen as the habitat feature of major importance, while for moose the state of local ecological succession is the primary consideration. The situation for elk (Cervus canadensis) (Cole 1983) is different in that regulation is seen to be primarily a social phenomenon, manifested as intraspecific competition for various resources. As with the moose and deer, however, extrinsic factors other than weather (e.g. predation) are seen only as modifying influences.

Pertinent to the present study, the fourth cervid review in this series deals with caribou (Bergerud 1983). Unlike the previous authors, he attributes no particular significance to habitat features per se in the control of populations. He postulates that those animals that live year round north of the tree line are controlled essentially by weather (which makes food unavailable and results in starvation), those in the "Lake State - Acadian Forests" declined from meningeal worm infestations, and those in the boreal and sub-alpine forests between (i.e. most caribou in existence today) are controlled primarily by natural predation. A complete critical evaluation of Bergerud's supporting information cannot be conducted here. Suffice it to say, however, that many of the same data-quality deficiencies identified for

the present study area (Sec. 4.1) apply also to Bergerud (1983). We believe his ideas warrant testing, but we again emphasize that until caribou populations can be adequately defined and measured, such tests are not possible.

The caribou in the present study area are in that area where Bergerud believes the primary factor influencing populations should be predation. In a previous review, Bergerud (1978) noted that predator numbers in southern British Columbia have generally remained low and recruitment has therefore been high. Because the caribou have nevertheless apparently declined in much of that area, Bergerud invoked another form of predation, overharvest by humans, in explanation but, as shown in Chapter 2, existing harvest data (if correct) generally do not support his case. In short, Bergerud's (1983) synthesis should be used as a source of stimulation and ideas for research, but not yet as a guideline for management.

6.2 Research Framework¹

6.2.1 Objectives and methods

Our objectives in developing a research framework were:

- to ensure that as many as possible of the potential research and management activities are considered;
- to provide a means for establishing a hierarchy of activities;
- to provide a means for rating the importance of carrying out those activities;
- to identify research needs that were related to management objectives.

The provincial management objective for caribou is to increase numbers to 20,000 (B.C. Ministry of Environment, Fish and Wildlife Branch 1979a). The greatest potential for increasing numbers lies in the north, but the overall provincial goal of maintaining species diversity within biophysical zones requires that caribou populations be maintained throughout their range. The basic management objective for the study area, then, is to maintain or increase caribou numbers, depending upon the area.

¹We acknowledge the participation of D. Eastman, R. Ellis, and R. Page in the development of the research framework.

Attainment of this objective implies the ability to accurately monitor population levels. At present, we do not have this ability (Sections 2.10.2 and 4.1). The stated objective for provincial populations -- 20 000 animals -- lies within the range of population estimates -- 10 000 to 20 000 animals. We therefore identified inventory as one of the broad categories of potential activities requiring consideration.

Population size is a function of productivity, immigration, mortality, and emigration. Although immigration and emigration may be important locally, we felt that they could be ignored on the broad scale of our study area. Having identified the basic categories of productivity and mortality, we listed the major components of those processes. Our lists were hierarchical and could be elaborated indefinitely; however, we limited ourselves to consideration of high-level components.

Having produced a hierarchical framework of potential research topics, we needed a procedure for determining which ones most needed investigation. We developed a set of three-point (low-medium-high) scales for use in rating each category and component: level of knowledge, importance, risk, inventory need, and research need. To assess level of knowledge, we took into consideration work done in the study area and work done elsewhere, if we believed it was relevant to the situation in British Columbia. Importance was defined as importance in achieving management objectives. The highest ratings were assigned to those factors which, within the range of values we expected to encounter in our study area, we judged most important in determining population size or our knowledge of population size. We defined risk as the risk of failure in meeting management objectives if we had underestimated the importance of a topic; topics that were rated high in importance were not rated for risk. We then rated our need for more information about each topic, distinguishing between those needs that can be met by additional inventory of animals, and those that require research. We tried to maintain a practical orientation by posing the question: if managers knew more about this topic, what would they be able to do more effectively?

6.2.2 Application of the research framework

The results of our application of the framework to information needs for caribou are summarized in Table 19.

TABLE 19. Application of the research framework

Topic	Level of knowledge	Importance	Risk	Inventory need	Research need
Inventory					
Identification of populations	L	H	-	H	L
Population dynamics (including numbers and composition)	L	H	-	H	H
Distribution (seasonal ranges and movements)	M	H	-	H	L
Productivity					
Age of first breeding	M	M	L	-	M
% of females ovulating	H	L	M	-	L
% of ovulating females fertilized	M	M	M	M	L
% of pregnant females giving birth to live young	M	L	M	M	L
Twinning rate	H	L	L	L	L
Mortality					
<u>Proximate factors</u>					
Starvation	L	L	H	-	M
Legal harvest	H	M	M	-	M
Poaching	L	M	M	-	M
Natural Accidents	L	L	L	-	M
Traffic fatalities	M	M	M	-	M
Disease and parasites	L	M	H	-	M
Predation	L	H	-	-	H
<u>Ultimate factors</u>					
<u>Cover</u>					
Thermal cover	M	M	M	L-M	L-H
Hiding cover	L	M	M	L-M	L-M
Insect cover	M	M	M	L-M	L-M
<u>Food</u>					
Nutrients	L	M	M	-	L-M
Energy	M	H	-	-	H
Climate	L	H	-	-	L

Inventory

Since management involves dealing with population changes, one of the most important ingredients in the management process is the ability to detect and/or recognize those changes. Without that ability, we can neither ascertain what management actions should be applied nor determine whether they have been successful. Data requirements for research are even more demanding than those for management. Whether directed to answering questions relating to management or research, those activities that gather data on animal distribution, numbers or group composition in the field are collectively referred to here as "inventory".

Under that general heading, three specific items, as discussed in previous sections, are listed. Identification of populations and determination of distribution relative to seasonal movements and ranges are both first order needs in terms of inventory, but there is little need for research relating to those topics. That is, the technology exists for obtaining the required information; it involves marking individuals. The need is simply for it to be employed, and we have suggested that public assistance in obtaining observations can enhance its value (Section 4.1).

There is no certain technology, however, for obtaining reliable information on numbers and composition of populations in the study area. There is therefore a need for research to develop and evaluate techniques that will enable the inventory needs to be met. Hatler (1983) has identified some of the potential sources of bias that should be considered and has outlined a general approach to the problem.

Productivity

Characteristics of productivity in caribou are known largely from work conducted outside the study area, but the overall pattern is consistent enough to allow extrapolation to British Columbia. Productivity, which we defined as the average number of live young born per female per year, depends on twinning rate, breeding interval, age at first breeding, and the number of females giving birth to live young. Multiple births can be ignored, as they are extremely rare in wild caribou (McDonald and Martell 1981), and the breeding interval is one year. Caribou have the genetic capability of conceiving at 1 1/2 years, but often do not. Reported pregnancy rates (excluding those based

on small sample sizes) at 1 1/2, 2 1/2, and 3 1/2 years varied from 2%, 48%, and 90%, respectively, in the Kaminuriak herd to 43%, 90%, and 95% in the George River herd (Dauphiné 1976; Bergerud 1980; Parker 1981). Age at first conception is related to indices of physical condition, such as body size and fat reserves (Dauphiné 1976; Parker 1981; Thomas 1982). We judged age of first breeding to be moderately important in influencing population size and identified a need for research on that topic.

The number of females giving birth to live young depends on the number of females ovulating, the number that are fertilized, and the rate of fetal resorption, abortion, and stillbirth. These have not been treated independently in most studies. However, the generally high natality rates observed in North American caribou -- 80-92% of adult females in studies reviewed by Bergerud (1980) -- indicate that they are not ordinarily limiting. Exceptions may occur under conditions of extreme nutritional stress: pregnancy rates of Peary caribou (Rangifer tarandus caribou) dropped suddenly and steeply when condition indices fell below threshold values (Thomas 1982). The causes of infertility were not determined. Peary caribou, which inhabit the Arctic islands, face severe forage restrictions during some winters; this level of nutritional deprivation probably does not occur in our study area.

Despite the overall pattern of a favourable birth rate in North American caribou, there are several reasons for conducting inventory to ascertain that natality is indeed adequate throughout the study area. The consequences of failing to identify a productivity problem could be at least moderately serious. We consider fertilization of ovulating females to be a possible problem area. In hunted herds, there is a possibility that the sex ratio may be modified to the extent that some females are not fertilized. In parts of southeastern British Columbia, the combination of habitat fragmentation and low numbers may have led to the failure of some females to be contacted by males during the rut. If so, then managers urgently need information about habitat characteristics of rutting areas, the role of tradition in the selection of rutting areas, and fall movement patterns. A finding that natality is consistently adequate would eliminate the need to further investigate that or other aspects of productivity at this time. However,

natality should be monitored in areas where harvest levels are high or where major habitat changes are occurring.

Of the potential topics of study under productivity, we identified only two -- age of first breeding, and percent of ovulating females fertilized -- as important to achieving management objectives. The others were rated low in importance because we felt that, within the range of variation we expect to encounter in the study area, they have little impact on numbers. Our needs for information about productivity require both research and inventory activity.

Mortality - proximate factors

Two broad categories of mortality factors are listed in Table 19. Those affecting individual animals directly are considered proximate factors; ultimate factors are more subtle, affecting survival mostly by setting the stage for the various proximate factors to act. Generally, opportunities to document specific causes of caribou deaths in the study area have been few and there may be important factors that have yet to be identified. For that reason, all factors listed in Table 19 are assumed to have at least a moderate research need at this time. Probably the only technique that can provide pertinent information is radiotelemetry applied to a sufficient sample of individuals, until death, so that the relative contributions of the various factors can be assessed. Inventory is not considered applicable in improving knowledge about the proximate factors, since it can only identify changes in numbers but cannot by itself distinguish between death and emigration.

Starvation: Food can be a proximate or an ultimate mortality factor. Death from starvation has been reported elsewhere in North America, where snow or ice conditions make food unavailable (Bergerud 1980), but we do not know whether that has occurred in the study area.

Hunting Mortality: Most legal harvest of caribou in British Columbia is now reported in conjunction with the Compulsory Inspection regulation. Poaching, which is possibly linked in its severity to increased access, has been identified as a potentially serious problem by some of the managers interviewed for this study, but because it is by nature a secretive activity,

it is poorly documented. Although poaching is primarily a management problem, determining its magnitude in relation to other mortality factors is a research problem. It is also important to realize that poaching could greatly confound local research results.

Accident Mortality: Natural accidents, as listed in Table 19, include events such as drownings, falls, or entrapment in avalanches. Young animals, particularly, may be subject to such mortality (e.g. LeResche 1968; Page, in prep.). The extent and nature of accident mortality will likely be determinable only by intensive studies involving use of radiotelemetry. Again, researchers should consider comparisons to determine whether such mortality increases or decreases as a result of habitat change through various kinds of developments. For example, hydro development may result in increased accident mortality by drowning.

Collision mortality of caribou on railways and highways is a separate kind of accident problem. It is like legal harvest in that it occurs at the hand of man, therefore all incidences could be reported. Unfortunately, such reporting does not now occur in all areas. Given better knowledge on the proportion of total mortality which is constituted by the traffic hazard, some research on ways to prevent or reduce it in local areas could be justified. Research might also be directed to determining whether there is any relationship between increased access and collision mortality.

Health Factors: The role of parasites and diseases as contributors to mortality could be important, as indicated by Bergerud's (1983) references to a parasite-induced decline along the southern edge of the range of woodland caribou. It seems worth noting that at least one observer believed that a disease factor may have been present during the 1930's decline in the Quesnel Highland area. Russell and Russell (1976a:5) reported an interview with a guide who had found "... a few dead caribou on Clearwater Lake ..." during that time, and wrote that "Some caribou shot...were discarded after it was observed that abnormally dark blood flowed from the wounds". Since little is known of the general health of caribou in the study area, all opportunities to examine live or dead animals should be taken.

Predation: By virtue of its high potential importance, predation is rated as having a high research need. The mountain ecotype is virtually unknown in that regard. The subject is complex. Although the bulk of Bergerud's (1983) discussion on predation refers to wolves, he has implicated other potential predators including bears (Ursus spp.), wolverines (Gulo gulo), and golden eagles (Aquila chrysaetos), and has documented heavy local predation on caribou calves by lynx (Lynx canadensis) in Newfoundland (Bergerud 1971). Two other large carnivores, the coyote (Canis latrans) and the cougar (Felis concolor), are also common in some parts of the present study area. The effects of predation may be additive or compensatory for several predator species and may be general for the prey species, or specific to particular sex and age classes.

It is also important to consider the potential interactions between predation and other factors such as weather (Elliott et al., in prep.) and, apropos in the context of this report, features of habitat. Bergerud (1978) noted that successional changes in habitat may result in local increases of moose and their predators (mostly wolves), and may thereby increase predation pressure on other local species including caribou. Habitat changes may also alter cover characteristics, providing new advantages for predator or prey. Developments such as roads, trails, and reservoirs may increase predator mobility or provide unprecedented access to important ranges or both. Habitat changes that result in concentrating caribou on particular ranges or reducing physical condition could also increase vulnerability to predation.

Mortality - ultimate factors

Of those ultimate factors potentially affecting mortality, we identified three broad topics: cover, food, and climate. We distinguished three types of cover: thermal cover, hiding cover, and insect relief cover.

Thermal cover: caribou sometimes use vegetative and topographic cover in a way that minimizes radiative and convective heat loss in cold weather, and reduces radiative heat gain in hot weather. They also use snowpatches in summer, although their importance as thermal cover is unclear. However, it is unlikely that thermal cover has an important role as an ultimate mortality factor for adult animals. Caribou have a variety of morphological and

physiological adaptations to cold, including pelage of high insulative value, a well-developed counter-current circulatory system in the extremities (Irving 1966), and a nasal heat exchange mechanism that minimizes heat and water loss during respiration (Langman and Taylor 1980). Hart et al. (1961) tested the responses of a 9-month-old caribou calf in winter pelage to temperatures as low as -55 C, and observed that it remained near the thermoneutral state even under severe winter conditions without increasing its metabolic rate. Caribou are also fairly heat-tolerant, maintaining normal temperatures through panting and perhaps perspiration. Yousef and Luick (1975) reported that respiratory frequency of reindeer increased slightly above 20 C and sharply above 30 C. Those findings suggest that the energy costs of cooling are not high at the summer temperatures usually encountered by caribou. Adult caribou are apparently able to maintain homeothermy under most conditions with little energetic expenditure.

In newborn caribou, maintaining homeothermy involves a greater energetic cost. One-day-old reindeer calves studied by Hissa et al. (1981) maintained their body temperature at -15 C, but increased their metabolic rate by a factor of five or six. Infant caribou calves subjected to temperatures of -1 to 4 C in combination with wind and snow also increased their metabolic rate as much as five times, and developed hypothermia when exposure was prolonged (Hart et al. 1961). Kelsall (1968) reported heavy calf mortality from adverse weather during some calving seasons in the Northwest Territories, but it is not clear whether other factors were involved. Some apparent instances of weather-related calf mortality are confounded by poor maternal nutrition due to a severe winter (Bergerud 1980). It is also uncertain whether or not thermal cover has any role in mitigating exposure of calves to bad weather. Both exposed alpine habitats and timberline forests have been documented as calving sites in the study area, and there are unconfirmed reports of calving in a variety of other habitats. It is not clear whether thermal cover is a factor in the selection of calving or post-calving habitat, and, if so, whether the thermal cover in question is likely to be affected by man's activities. The possibility of traditional use of specific forested sites that are vulnerable to logging or other disturbances cannot be ruled out. Because of its possible importance to newborn animals, we judged thermal cover

moderate in importance and risk. Information on this topic could be obtained as part of other inventory and research undertakings.

Hiding cover: Hiding cover is less important to caribou than to many other cervids. The species has evolved in open habitats, and has developed anti-predator strategies that are appropriate to open habitats. The anti-predator strategies of mountain caribou, which spend considerable time in small groups in closed habitats, are not well understood (Section 3.1). Mountain caribou have been reported to run toward forest cover when disturbed, but it is unclear whether they were actually seeking cover or whether the trees were simply in the opposite direction from the source of the disturbance. Whether or not caribou deliberately use terrain and vegetation as hiding cover, their use of forested areas likely helps them to escape detection by predators and, especially, by hunters. The question of the importance of hiding cover to caribou is directly relevant to the management question of whether or not to provide continuous forest cover along movement routes. We judged hiding cover to be moderate in importance and risk, and identified a need to gather information on this topic through fine-grained inventory work, research, or both.

Insect cover: During the summer, caribou are harassed by flying insects -- mosquitoes (Aedes spp., Culex spp.), botflies (Cephenemyia spp.), warbleflies, and others. They seek windswept terrain, snowpatches, and shady forests for relief from insect harassment. If insect cover is not available, caribou probably move more (Bergerud 1974). Activity due to insect harassment increases energy costs and reduces grazing time, thereby limiting summer weight gain (Reimers 1980; Helle and Tarvainen 1984). We judged insect cover to be moderately important in its effect on population levels, but we do not know whether the need for insect cover has any management implications. Managers need to know what, if any, special characteristics are required in forests as insect relief cover. As for the other categories of cover, we identified a low to moderate need for the acquisition of additional information.

Nutrients: As an ultimate factor, nutritional status affects mortality by affecting the animals' ability to withstand other threats, such as predation and disease. We distinguished between the two essential resources provided by food -- nutrients and energy. What is known about caribou nutrition is based mainly on extrapolation from studies of captive reindeer. Caribou are well adapted to a low-protein diet, and have a superior ability to recycle urea to the rumen (Wales et al. 1975; White 1975). The high levels of carbohydrate in lichens meet the need of rumen microflora for a readily fermentable energy source for this process (White 1975). The nitrogen balance of reindeer studied by Syrjälä et al. (1980) was more strongly influenced by the intake of energy than by the intake of digestible crude protein. For these reasons, it seems improbable that protein deprivation could be a significant mortality factor.

Mineral nutrition warrants further investigation. Staaland et al. (1980, 1982) presented evidence that reindeer and caribou experience seasonal sodium deficiencies. Hyvärinen et al. (1977) found that reindeer grazing on very poor winter ranges suffered severe mineral deficiencies, and that reindeer on near normal winter ranges experienced low levels of serum calcium. Those authors suggested that reindeer compensate for the low mineral content of winter forage by using the skeleton as a mineral bank, even under normal winter conditions. As well as improving our understanding of a factor that might affect animal condition and thus population levels, more information about mineral nutrition would help answer managers' questions about the importance, if any, of protecting mineral licks. We judged that nutrition, especially mineral nutrition, should receive a low to moderate research effort.

Energy: Energetics is a complex topic that has interactions with many other potential areas of study, such as distribution, age of first breeding, number of females giving birth, and response to disease, predation, harassment, and thermal stress.

The energy balance of an animal is a function of energy intake and energy output. Energy intake depends on amounts of forage available, amounts actually eaten, and the metabolizable energy in the forage. Availability of forage is affected by snow conditions. Amounts actually consumed depend on physical and behavioural characteristics of the animals -- bite size, height,

rumen capacity, feeding behaviour. The metabolizable energy is the amount remaining after losses through feces, urine and methane. Energy output is a function of maintenance costs, such as basal metabolism and thermoregulation; of activity costs, such as locomotion and responses to harassing stimuli; and of production costs, such as body and antler growth, fat deposition, and reproduction.

Energy balance fluctuates over time because of age-specific, sex-specific, and seasonal variations in energy consumption and in maintenance, activity, and production costs. Studies of reindeer and captive caribou have shown that some of those fluctuations are genetically determined, and occur even when environmental conditions are held constant (McEwan and Whitehead 1970; Nilssen and Ringberg 1980; Ringberg et al. 1980). Summer is a period of rapid fat deposition in both sexes. Male caribou, like other cervids, reduce food intake to a very low level during the rut, and enter winter in poorer conditions than females. During winter, both sexes voluntarily reduce caloric intake to 35-40% from summer levels. Metabolic rate is lowered, and fat deposits are mobilized.

Taking into consideration generalized patterns of energy balance and environmental conditions in the study area, we have attempted to identify periods in the annual cycle when energy balance might be a problem (Table 20). Those periods correspond to the seasons for which we discussed habitat use in Chapter 2. A better understanding of caribou energetics on a seasonal basis would help managers in two ways. First, it would help them determine the relative importance of habitat protection in the various seasonal ranges. Second, it would help them determine the relative importance of managing habitat changes that affect energy intake and habitat changes that affect energy output.

Spring is a period when energy demand is high, and we judged that energy availability in the study area is also high. A problem in energy balance could occur when green-up is late and the animals are forced to remain under winter conditions longer than usual. During the calving period, males tend to remain on spring ranges, but females seek other habitats, which may have lower forage availability. We did not identify an energy problem during calving, even for cows, since the period is brief. Newborn calves, however, are

TABLE 20. Annual cycle of caribou

Season	Energy demand		Energy availability		Major events
	Female	Male	Female	Male	
Spring	H	H	H	H	Forage green-up; recover and energy balance. Females - maximum energy demand of pregnancy.
Calving	H	H	M	H	Forage green-up; recover and energy balance. Females - calving habitat may have lower forage availability.
Summer	H	H	H	H	Fat deposition. Antler growth. Females - lactation. Insect harassment.
Rut	M	L	H	H	Breeding activity. Males - reduce food intake.
Early winter	L	M	L	L	Food intake reduced by 35-45%. Males - increased food intake after rut. Negative energy balance.
Late winter	L	L	L	L	Food intake still reduced. Negative energy balance.

vulnerable to mortality when weather conditions are adverse, and their vulnerability could be related to the energetic status of their mothers during late winter, spring, and the calving period.

Energy demands remain high during summer. We considered energy availability unlimited during that period, and judged that if any energy problems occur, they would be due to harassment. Data presented by Reimers (1980) suggest that insect and human harassment of reindeer on high-quality summer range can limit summer weight gain and increase dependency on high-quality winter range. Helle and Tarvainen (1984) reported a significant relationship between the level of insect harassment during summer and weight of reindeer calves in fall. The effects of insect harassment on the activity budget of caribou in the study area have not been measured, but may be great. The level of infection by warble fly larvae of caribou hides from the mountains of British Columbia and Alberta is among the highest in North America (Kelsall 1975).

At the time of the rut, energy demand is sharply reduced for males, and begins to drop for females. Energy availability is still relatively high. Early and late winter typically constitute a period of low energy availability and low energy demand, although males appear to increase food intake slightly after the rut (Nilssen and Ringberg 1980). Caribou, like other northern cervids, are normally in a state of negative energy balance during that period. As the energy supply is depleted, they become increasingly susceptible to other mortality factors. Circumstances that could potentially bring about increased vulnerability include inadequate deposition of fat during the growing season, low forage availability in winter, a late spring, harassment during winter by man or predators, or a combination of those factors.

We identified a need for an overall investigation of energetic relationships of caribou on an annual basis which would include the following topics:

- What are the relationships between harassing stimuli (insects, predators, humans) and the energetic status of caribou?
- What are the relationships between weather and snow conditions and the energetic status of caribou?

- What role, if any, do forests have in mitigating the effects of harassment and adverse weather on caribou?
- What are the relationships between the energetic status of adult caribou and mortality rates?
- What are the relationships between the energetic status of females and calf survival?
- Given the energetic status of caribou at the beginning of winter and the energy demands on the animals during winter, is energy availability on winter ranges adequate?

The adequacy of energy availability on winter ranges is an important research topic. To make rational decisions about habitat protection, managers need to know at what levels of caribou population and of habitat alienation the winter forage base becomes a limiting factor. Questions about adequacy of winter ranges must be addressed separately for the two ecotypes. For mountain caribou, removal of mature trees eliminates winter forage for over 100 years. Given the present uncertainty about winter forage requirements, conservative management of winter ranges is appropriate. Diminishing that uncertainty is an important goal of research on energetics. Research on the adequacy of winter forage for mountain caribou will likely require the development of improved methods for quantifying lichen biomass (Chapter 4). The research questions on forestry practices and arboreal lichen abundance (Section 3.3) should be postponed until more is known about the adequacy of the winter forage base for mountain caribou.

For northern caribou, an examination of the adequacy of the winter forage base should begin with a literature review. Information from outside the study area on the availability of terrestrial forage in relation to forest succession should be reviewed, and its applicability to the study area assessed.

For both ecotypes, the adequacy of the winter forage base can be assessed only if food habits are known, at least broadly. Existing information on food habits of mountain caribou is probably adequate for that purpose. If uncertainties about the winter food habits of northern caribou in the study area cannot be resolved through field observations and extrapolation from outside the study area, then it may be necessary to pursue improvements in the methodology of fecal fragment analysis, as discussed in Section 4.3.2.

Climate: The effects of climate as a mortality factor, through the direct action of weather, have been discussed. We also acknowledge the potential of long-term climate changes to affect the survival of caribou in the study area. Changes in winter snowpack or perhaps summer snowpack would be expected to have a significant impact on caribou. However, we do not consider the effects of long-term climate change to be justified as a research topic.

6.2.3 Interactions

Because of our need to organize and assess a variety of potential research topics, the research framework that we developed treated separately the various factors that affect population levels. We recognize that those factors are actually interdependent, and that some of the most critical information needs concern relationships among factors. We identified the following broad questions, which we feel should guide the research undertaken under the categories described in Section 6.2.2:

What is the relative impact on caribou of access development vs. habitat alteration in their ranges? Better information on this topic is essential to making decisions about strategies for managing forests in caribou ranges, as discussed in Chapter 3.

Why do caribou select the habitats they do? To predict how caribou will respond to alterations in their habitat, managers need to know more about the functional relationships between caribou and the habitats they select. Many of the information needs identified by managers (Sections 2.10.2 and 2.10.3) concern habitat selection. Chief among them are the following:

- What is the functional importance of forests to northern caribou?
- What is the functional importance of low elevation winter ranges to mountain caribou?
- What is the role of tradition in the selection of rutting areas and calving areas? What habitat characteristics are important? How are traditions and habitat characteristics related to reproductive success?

- Why do caribou move long distances from one seasonal range to another that is apparently identical?

What are the relationships among the quality and quantity of caribou habitat, caribou numbers, and animal condition? These interactions may involve forage, risk of predation, risk of disease, interspecific relationships, intraspecific relationships, or other factors. Answers to this and to the previous question may require that the methodological problems of use/availability studies, as described in Section 4.3, be addressed.

What are the relationships between animal condition and the response of caribou to stresses, such as predation, human disturbance, and insect harassment?

What are the relationships between caribou numbers and climatic variations over time and space?

What is the optimum size, shape and arrangement of habitat reserves for caribou? The rationale for this question was discussed in Chapter 3.

What variations in habitat selection strategies exist within ecotypes, and what are the implications of those variations for managers and researchers? Are there some segments of a population that tend to remain at high elevations year-round, and others that tend to remain low? Are there some segments of a population that tend to use the same ranges in summer and winter, and others that tend to use discrete summer and winter ranges? As noted in Section 5.3.1, differences in mobility may have implications for management.

In addition to the broad biological questions listed above, we identified a methodological problem that involves interactions. We consider it likely that in at least some cases, former caribou range which is now either vacant or supporting only greatly diminished numbers of caribou could nevertheless support viable populations. Because the logical first step in management of such areas would be relocation of animals from elsewhere, we identify a need for research to develop the appropriate methods. Aside from basic logistical considerations are several biological questions that should be addressed

include: What should be the numbers and sex/age composition of an introduced group? What are the optimum timing, climatic conditions, and seasonal location for a transplant? How similar should source and transplant area habitats be? If there are behavioural morphs in a local population such that some are relatively sedentary and others more prone to wander, which might be more suitable for relocation? Should areas with well-developed moose-wolf systems be avoided, or is local predator control in the early stages sufficient protection?

Transplant programs should be undertaken in a consistent and systematic manner, designed to provide data on such questions; released animals should be radio-collared and regularly monitored. A period of radio-tracking potential transplant animals in their home area may be advisable before relocating them, to assist researchers in discovering what kinds of individuals are best for that purpose.

6.3 Selection of Research Areas

Selection of suitable study areas is one of the most important aspects in the design of a research project. The following list identifies factors that should be considered:

Logistics - The distance of a potential study population from various facilities and services (e.g. living quarters, working quarters, air charter opportunities, road access and source of supplies) is important as it relates to research costs and a human convenience factor.

Biological Appropriateness - Some biological questions are more relevant in some geographical areas than in others.

Population Size - Certain kinds of research may require populations sufficient either to ensure adequate sample sizes or to allow methods that might be destructive to individual animals.

Public Use and Interest - Funding may be more easily justified for a population with a high public profile.

Experimental Design - Considering the specific topic of research, the best study area is the one with the fewest confounding factors.

Protection from Interference - Contingencies such as harvest of collared animals or development of research control areas can result in premature termination of projects or serious alteration of results.

Existing Information Base - The relative appropriateness of a particular research topic in a particular area may be evident on the basis of what is already known in that area.

Ability to Contact Animals - If animals are typically difficult to locate in a particular area, they may not be suitable for some types of research, particularly if telemetry is not used.

Management Priority - The suitability of a particular population may be partially dependent upon the question of what we need to know in relation to local management needs.

Extrapolation Potential - Some areas may be particularly desirable for study since they may enable extrapolation of results to other areas in relation to particular ecotypes, biogeoclimatic zones or physiographic regions.

Potential for Incidental Information - Obvious opportunities to gather additional data simultaneously or incidentally may make one area more desirable than another.

In addition to the above general considerations, the following selection principles are specific to caribou in southern and central British Columbia:

1. Research effort should be directed to both the mountain and northern ecotypes. It is important to consider that among the animals identified as northern in the broad study area for this report, those in the Peace subregion (Region 7) are at the southern edge of a fairly continuous distribution to the north, while those in the Tweedsmuir Park area (Regions 5 and 6) are relatively isolated both from other northern animals and from the mountain ecotypes to the east. Among the northern ecotype, the Tweedsmuir animals seem the more important for research at this time both because of the high biological viability of their population(s) and because they may possibly be unique in some ways.

2. It will be important to study in both developed and pristine areas, preferably comparing the two.
3. Given the relatively low level of knowledge about caribou over the entire range in the present broad study area, the areas with highest management priorities may also have the greatest research needs.
4. Local information can only be obtained from local studies, but local studies can provide information of more widespread and general applicability if the data are collected and compiled in a consistent manner and made available for synthesis. Research and inventory must be co-ordinated throughout the range of caribou in the province.

Provincial managers and researchers will ultimately select specific caribou research study areas, but we believe that three specific areas should be highlighted based on our work. The Tweedsmuir population centre is a good prospect for research because of the blend of high biological viability, high resource conflict, and low present knowledge about the animals. The southern Selkirks population, is characterized by low viability, high conflict and very high public interest. In this case, the social reason has apparently been sufficient for adoption of a research program on those animals. The Wells Gray Park and Prince George East population centres were shown to be of considerable potential importance in a biogeographical sense (high management priority), but more information on the animals is badly needed to enhance management, especially in the Region 7 centre.

6.4 Research Recommendations

We based our recommendations for research on an analysis of information needs, in the context of management objectives and of current theory. The primary management objective for caribou in the study area is to maintain or increase numbers. Although Bergerud (1983) held that the major limiting factor for caribou over most of the species' range is predation, we did not find that the relationship has been demonstrated for the present study area. Other factors affecting caribou numbers must also be considered.

Our analysis of information needs was based on an a priori research framework. We identified inventory, productivity, and mortality as three broad categories of potential research activity requiring consideration, the latter two because they are the basic biological processes determining numbers, and the former because it is the way we assess numbers. Within those broad categories we made hierarchical lists of their major components. We then rated each component according to existing level of knowledge, importance in achieving management objectives, risk of failure to meet management objectives if a component is more important than we had thought, need for obtaining additional information through research.

By applying the research framework, we identified topics that require investigation through inventory, research, or both. Those topics are summarized below. Topics that are rated low to moderate in priority do not necessarily warrant investigation on their own, but researchers and managers should be aware of the need to gather relevant information when opportunities present themselves.

Inventory topics

There is a high-priority need for identification of caribou populations and for better information on their numbers, composition and distribution in the study area. Identification of populations and distributions is accomplished primarily through radiotelemetry. In addition, the potential of public assistance for improving knowledge of caribou populations should be developed. The need for better methods of determining caribou numbers and composition is discussed below.

There is a moderate - priority need for inventory to assess the adequacy of natality, especially where hunting may have reduced the number of breeding bulls or where the combination of habitat fragmentation and low numbers may have interfered with the rut.

There is a low-to-moderate-priority need to evaluate the use of thermal, hiding, and insect cover. That could be done as a part of other studies through the collection of data on local distributions.

Research topics

There is a high-priority need to develop methods of obtaining information on numbers and composition of populations. Research on that topic is required to meet the high-priority inventory need stated above.

There is a high-priority need to investigate the energetic relationships of caribou on an annual basis. The importance of the factors that affect the animals' seasonal energetic status, such as range adequacy, harassing stimuli, and weather, should be assessed. The relationships between habitat, especially forested habitat, and the action of those factors on caribou should be examined. The study should also address the relationships between the energetic status of caribou and their productivity and natality.

Studies of energetics and range relationships may require some additional literature review and methodological research. If forage availability on winter ranges is to be measured, then there is a need for improved methods of quantifying lichen biomass. If fecal fragment analysis is used to determine food habits, then the accuracy of the technique should be assessed and the feasibility of developing correction factors investigated. If range relationships of northern caribou are examined, then information from outside the study area on the availability of terrestrial forage in relation to forest succession should be reviewed, and its applicability to the study area assessed.

There is a moderate-to-high-priority need to determine the magnitude of proximate mortality factors other than predation. Studies of mortality factors, such as poaching, traffic fatalities, and accidents, should include their relationships with man-caused changes in the habitat.

There is a moderate-priority need to determine age at first breeding on various ranges. Age-specific pregnancy rates vary among populations, and can be at least moderately important in influencing population size.

There is a low-to-moderate-priority need to evaluate the use of thermal, hiding, and insect cover. This could be done through research activities as well as through inventory activities, and could be combined with other studies.

There is a low-to-moderate-priority need to investigate mineral nutrition on various ranges. Evidence from outside the study area indicates that reindeer and caribou may experience seasonal mineral deficiencies, even under near-normal winter conditions.

Interactions among topics

The inventory and research topics given above are not independent of one another and are not proposed as discrete research packages; we listed them as we did in order to facilitate the allocation of effort. Recognizing that the factors that determine population levels of caribou are actually interdependent, we identified a set of broad biological questions, which we feel should guide the inventory and research activities undertaken under the categories listed above:

What is the relative impact on caribou of access development vs. habitat alteration in their ranges?

Why do caribou select the habitats they do?

What are the relationships among the quality and quantity of caribou habitat, caribou numbers, and animal condition?

What are the relationships between animal condition and the response of caribou to stresses, such as predation, human disturbance, and insect harassment?

What are the relationships between caribou numbers and climatic variations over time and space?

What is the optimum size, shape and arrangement of habitat reserves for caribou?

What variations in habitat selection strategies exist within ecotypes, and what are the implications of those variations for managers and researchers?

The following two questions also involve interactions among topics, but are primarily methodological in nature:

What are the theoretical, statistical, and practical problems involved in comparing use and availability of habitat types, and how can they be resolved?

What are the optimum conditions and methods for relocating caribou?

Conclusions

Potential research study areas must be screened for a variety of factors that affect their suitability, but we recommend that first consideration be given to the three population centres recommended for high-priority caribou management.

To ensure that information obtained in local studies becomes available for synthesis, we recommend that caribou inventory and research be co-ordinated at a provincial level.

7 GLOSSARY AND LIST OF ABBREVIATIONS

AAC

Allowable Annual Cut. The annual rate of harvest set for a managed unit for a 20-year period and reviewed every five years.

AT

Alpine Tundra Biogeoclimatic Zone.

BWBS

Boreal White and Black Spruce Biogeoclimatic Zone.

CLI

Canada Land Inventory.

close utilization

Timber harvesting standards requiring that all merchantable stems 7.1-in. (17.5-cm) or more in DBH.

Compulsory Inspection

Regulation requiring successful hunters of specified species (including caribou) to report to a designated Fish and Wildlife centre and present pertinent data and portions of the carcass for inspection.

CWH

Coastal Western Hemlock Biogeoclimatic Zone.

DBH

Diameter at breast height.

ELUC

Environment and Land Use Committee.

EPA

Environmental Protection Area. An area designated during forest inventory as being environmentally sensitive or critically valuable for non-timber resources.

ESSF

Engelmann Spruce - Subalpine Fir Biogeoclimatic Zone.

GMA¹

Game Management Area. Administrative subdivision of the province for wildlife management, 1956-1966. The present study area covers all or parts of 13 such units.

¹See Appendix 2 for a list that cross-references GMA's, GMU's and MA's.

GMU¹

Game Management Unit (also referred to in other documents as MU [Management Unit]). Administrative subdivision of the province for wildlife management, 1975-present. The present study area covers all or parts of 79 such units.

Hunter Sample

A questionnaire to a sample of British Columbia resident hunters regarding the dates, locations and species of their hunting effort and success.

ICH

Interior Cedar - Hemlock Biogeoclimatic Zone.

IDF

Interior Douglas-fir Biogeoclimatic Zone.

intermediate utilization

Timber harvesting standards requiring that all merchantable stems 11.1-in. (27.5-cm) or more in DBH be utilized.

LRSY

Long Run Sustainable Yield. The estimated maximum amount of merchantable wood fibre which can be produced perpetually from the productive and accessible forest sites that make up the net productive land base.

MA¹

Management Area. Administrative subdivision of the province for wildlife management, 1967-1974. The present study area covers all or parts of 18 such units.

MS

Montane Spruce Biogeoclimatic Zone.

NTS

National Topographic System.

PSYU

Public Sustained Yield Unit. An area of Crown land managed for sustained yield of timber through the Ministry of Forests. PSYU's are now being replaced by TSA's.

RAB

Resource Analysis Branch.

SBS

Sub-Boreal Spruce Biogeoclimatic Zone

¹See Appendix 2 for a list that cross-references GMA's, GMU's and MA's.

Supply Block

A unit within a TSA that is homogeneous with respect to transportation routes, forest characteristics, and harvesting systems. The short-term wood supply is assessed within Supply Blocks.

TFL

Tree Farm License.

TSA

Timber Supply Area. A geographic unit established by the Ministry of Forests for analysing, planning and managing forest, range and recreation resources.

TSB

Terrestrial Studies Branch.

8 LITERATURE CITED

- Ahti, T. 1962. Ecological investigations on lichens in Wells Gray Provincial Park, with special reference to their importance to mountain caribou. Dep. of Botany, Univ. of Helsinki. Unpubl. manuscript. 69 p.
- Ahti, T. and R.L. Hepburn. 1967. Preliminary studies on woodland caribou range, especially on lichen stands, in Ontario. Ont. Dep. of Lands and Forests, Research Report (Wildlife) No. 74:1-134.
- Alexander, R.R. 1973. Partial cutting in old-growth spruce-fir. USDA For. Serv. Res. Pap. RM-110, Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 16 p.
- _____. 1974. Silviculture of subalpine forests in the central and southern Rocky Mountains: the status of our knowledge. USDA For. Serv. Res. Pap. RM-121, Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. 88 p.
- _____. 1977. Cutting methods in relation to resource use in central Rocky Mountain spruce-fir forests. J. Forestry 75:395-400.
- Anderson, O.J. n.d. Progressive cutting (or continuous harvest): a review. Jacobson Bros. Forest Products Ltd., Williams Lake, B.C. Unpubl. report. 7 p.
- Annas, R.M. and R. Coupé, (editors) 1979. Biogeoclimatic zones and subzones of the Cariboo Forest Region. B.C. Min. For., Victoria, B.C. 103 p.
- Anonymous. 1983. Five problem areas for reforestation. J. Forestry 81:448.
- Antifeau, T.D. 1979. Draft of preliminary analysis of arboreal lichen inventory, ESSF Zone, mountain caribou winter range, N. Thompson Watershed, B.C. Min. Environ. Fish and Wildlife Branch, Kamloops, B.C. 21 p.
- _____. 1980. North Thompson River mountain caribou study. A progress report to the B.C. Min. Environ. Fish and Wildlife Branch, Kamloops, B.C. 35 p.
- Banfield, A.F. 1961. A revision of the reindeer and caribou, genus Rangifer. Nat. Museum Canada Bull., 177:1-137.
- Beets, M.L. and D.E. Russell. 1976a. Recommendations for logging mountain caribou habitat in the Quesnel Highland. Cariboo Region Technical Report, Fish and Wildlife Branch, Williams Lake, B.C. 8 p.
- _____. 1976b. Ecology of arboreal lichens and their role in ungulate ecology, especially mountain caribou ecology. Cariboo Region Technical Report HP-76-1(b), Fish and Wildlife Branch, Williams Lake, B.C. 20 p.

- _____. 1976c. Mountain caribou - a state of knowledge. Cariboo Region Technical Report HP-76-1(c), Fish and Wildlife Branch, Williams Lake, B.C. 25 p.
- _____. 1976d. Ungulates in a snow environment. Cariboo Region Technical Report HP-76-1(d), Fish and Wildlife Branch, Williams Lake, B.C. 14 p.
- Bergerud, A.T. 1971. The population dynamics of the Newfoundland caribou. Wildl. Monogr. 25. 55 p.
- _____. 1974. The role of the environment in the aggregation, movement and disturbance behavior of caribou. Pp. 552-584 In V. Geist and F. Walther (editors). The behavior of ungulates and its relation to management. IUCN Publ. New Series 24. Morges, Switzerland.
- _____. 1978. The status and management of caribou in British Columbia. B.C. Fish and Wildlife Branch Report, Victoria, B.C. 150 p.
- _____. 1980. A review of the population dynamics of caribou and wild reindeer in North America. P. 556-581 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- _____. 1983. The natural population control of caribou. P. 14-61 In F.L. Bunnell, D.S. Eastman and J.M. Peek (editors). Symp. on natural regulation of animal populations, Forest, Wildlife and Range Exp. Stn., Proc. No. 14. Univ. of Idaho, Moscow, Idaho.
- Bergerud, A.T. and H.E. Butler 1978. Life history studies of caribou in Spatsizi Wilderness Park 1977-1978. B.C. Parks Branch Report, Victoria, B.C. 156 p.
- Bergerud, A.T., R.D. Jakimchuk, and D.R. Carruthers. 1984. The buffalo of the north: caribou (Rangifer tarandus) and human developments. Arctic 37:7-22.
- Bergerud, A.T. and L. Russell. 1964. Evaluation of rumen food analysis for Newfoundland caribou. J. Wild. Mgmt. 28(4):809-814.
- Bjorge, R. 1982. Habitat, biology and management of woodland caribou on the Redrock Creek winter range in west central Alberta. Paper presented at Symp. on Wildlife Relationships in Old-Growth Forests, Northwest Section, The Wildlife Society, 14-16 April 1982. Juneau, Alaska.
- Bloomfield, M. 1979. The ecology and status of mountain caribou and caribou range in Central British Columbia. M.Sc. thesis, Univ. of Alberta, Edmonton, Alta. 318 p.

- _____. 1980a. The impact of development, settlement and associated activities on mountain caribou in central British Columbia, Canada. Pp. 705-715 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- _____. 1980b. Patterns of seasonal habitat selection exhibited by mountain caribou in central British Columbia, Canada. Pp. 10-18 In E. Reimers, E. Gaare and S. Skjenneberg, (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Bloomfield, M. and C. Bloomfield. 1981. Description and classification of mountain caribou range in the Hungary Creek watershed of central British Columbia. Unpubl. report. 128 p.
- Bloomfield, M., J. Edmonds, and J. Steele. 1981. First annual report of the Berland - A La Peche caribou study. Alberta Dep. of Energy and Natural Res. Fish and Wildlife Division, Edson, Alta. 63 p.
- B.C. Ministry of Environment. 1981. Woodland caribou in the Thompson-Nicola Resource Region. Victoria, B.C. 18 p. + separate appendix.
- B.C. Ministry of Environment, Fish and Wildlife Branch. 1979a. Preliminary caribou management plan for British Columbia. Victoria, B.C. 30 p.
- _____. 1979b. Proposed wildlife management plan for British Columbia. Victoria, B.C. 84 p.
- _____. 1980a. Region 5 Cariboo Zone mountain caribou management plan. Williams Lake, B.C. Draft. 2 p.
- _____. 1980b. Snowmobile conflict with the Telkwa caribou herd. Smithers, B.C. 11 p.
- B.C. Ministry of Environment, Resource Analysis Branch. 1977. Wildlife resources of the northeast coal study area 1976-1977. RAB Bull. 6, Victoria, B.C. 51 p. + appendices.
- _____. 1979. Wildlife resources of the northeast coal study area 1977-1978. RAB Bulletin 12, Victoria, B.C. 51 p. + appendices.
- B.C. Ministry of Forests. 1980. Catalogue of output statements. Inventory Branch, Forest and Range Statistics Section, Victoria, B.C. n.p.
- _____. 1982a. Kamloops - Caribou Habitat Study. Planning Branch, Victoria, B.C. Unpubl. report. 11 p.
- _____. 1982b. Ministry Policy Statement "Timber Supply Areas (TSA) - Planning", III-PLA-003. Victoria, B.C.
- _____. 1983. AAC Rationale Report. Planning Branch, Victoria, B.C. 145 p.

- Bunnell, F.L. 1978. Constraints of small populations. P. 264-287 In P. Scott (Chairman): Threatened deer. Int. Union Conserv. Nature and Natural Resour., Morges, Switzerland.
- Bunnell, F.L. and D.S. Eastman. 1976. Effects of forest management practice wildlife in the forests of British Columbia. Proc. Div. One., 16th IUFRO World Conf., Oslo, Norway, June 21-23, 1976. 38 p.
- Bunnell, F.L., D.S. Eastman and J.M. Peek (editors). 1983. Symp. on natural regulation of animal populations. Forest, Wildlife and Range Exp. Stn., Proc. No. 14, Univ. of Idaho, Moscow, Idaho. 225 p.
- Bunnell, F.L., R. Ellis, S. Stevenson, and D.S. Eastman. 1978. Evaluating ungulate populations and range in British Columbia. Trans. N. Amer. Wildlife and Natural Resour. Conf. 43:311-322.
- Bunnell, F.L. and G.W. Jones. 1984. Black-tailed deer and old-growth forests - a synthesis. P. 411-420 In W.R. Meehan, T.R. Merrell, Jr. and T.A. Hanley, (editors). Proc. Symp. Fish and Wildlife Relationships in Old-Growth Forests, 12-15 April 1982, Juneau, Alaska. Amer. Inst. Fish. Res. Biol. 425 p.
- Cariboo Forest Region. 1980. Quesnel Timber Supply Area yield analysis report. B.C. Min. For., Victoria, B.C. 87 p.
- _____. 1981a. 100 Mile House Timber Supply Area yield analysis report. B.C. Min. For., Williams Lake, B.C. 66 p.
- _____. 1981b. Williams Lake Timber Supply Area yield analysis report. B.C. Min. For., Williams Lake, B.C. 109 p.
- Carlton, J. 1982. Selkirk mountain caribou winter project: Unpubl. final report. Idaho Panhandle National Forests, Bonners Ferry, Idaho. Unpubl. report. 10 p. + appendix.
- Child, K.N. 1978a. Bergerud's caribou report. B.C. Fish and Wildlife Branch, Prince George, B.C. 2 p.
- _____. 1978b. Placental and hematological tissues in fecal samples of a maternal woodland caribou (Rangifer tarandus montanus). J. Mammal. 59:631.
- Churchill, B. and F. Harper. 1979. Northeast coal study internal report. B.C. Min. Environ., Fish and Wildlife Branch, Fort St. John. Unpubl. report.
- Cole, G.F. 1983. A naturally regulated elk population. P. 62-81 In F.L. Bunnell, D.S. Eastman and J.M. Peek (editors). Symp. on natural regulation of animal populations. Forest, Wildlife and Range Exp. Stn., Proc. No. 14, Univ. of Idaho, Moscow, Idaho. 225 p.
- Cox, L. 1970. An isolated caribou herd in the midst of a developing area. B.C. Fish and Wildlife Branch, Smithers, B.C. Mimeo. 3 p.

- Crown Zellerbach Canada, Ltd. 1980. An analysis of forest management options for the Okanagan Timber Supply Area, Kamloops Forest Region. Prepared for B.C. Min. For. and Shuswap Okanagan For. Assoc. 93 p.
- Daubenmire, R. and J.B. Daubenmire 1968. Forest vegetation of eastern Washington and northern Idaho. Wash. Agric. Exp. Stn. Tech. Bull. 60. 104 p.
- Dauphiné, T.C., Jr. 1976. Biology of the Kaminuriak population of barren-ground caribou. Part 4. Growth, reproduction, and energy reserves. Can. Wildlife Serv. Report Series 38. 71 p.
- Day, R.J. 1963. Spruce seedling mortality caused by adverse summer micro-climate in the Rocky Mountains. Can. Dep. For., Research Branch Publ. 1003, Ottawa, Ont. 36 p. (Cited by Alexander 1974.)
- Dearden, B.L., R.M. Hanson, and R.E. Pegau 1975. Plant fragment discernibility in caribou rumens. P. 257-277 In J.R. Luick, P.C. Lent, D.R. Klein, and R.G. White (editors). Proc. 1st Int. Reindeer/Caribou Symp., 9-11 August 1972, Univ. of Alaska, Fairbanks, Alaska.
- Demarchi, D.A. (In preparation). Wildlife ecosystems of British Columbia. Surveys and Resource Mapping Branch, Ministry of Environment, Victoria, B.C. Draft report and map.
- Dick, J. 1979. Workshop on logging/caribou relationships with specific reference to the North Thompson and Raft PSYUs, Kamloops, B.C., 15-16 May 1979. Proc. ELUC Secretariat, B.C. Min. Environ. Victoria, B.C. 73 p.
- Edmonds, J. 1981. Caribou calving survey in Willmore Wilderness, Jasper National Park and adjacent portions of British Columbia. Alberta Dep. of Energy and Natural Res., Fish and Wildlife Div. Edmonton, Alta. Unpubl. report. 17 p.
- _____. 1982. Caribou rutting survey in Willmore Wilderness Park, Jasper National Park, adjacent areas in British Columbia and Little Smoky River. Alberta Dep. of Energy and Natural Res., Fish and Wildlife Div., Edmonton, Alta. Unpubl. report. 19 p.
- Edmonds, J. and M. Bloomfield. 1981. Fifth progress report of the Berland - A La Peche caribou study. Alberta Dep. of Energy and Natural Res., Fish and Wildlife Div. Edmonton, Alta. Unpubl. report. 82 p. + appendix.
- Edmonds, J. and M. Bloomfield. 1984. A study of woodland caribou (Rangifer tarandus caribou) in west central Alberta, 1979 to 1983. Alberta Dep. of Energy and Natural Res., Fish and Wildlife Div., Edmonton, Alta. 203p.

- Edwards, R.Y. 1954. Fire and the decline of a mountain caribou herd. J. Wildl. Manage. 18:521-526.
- _____. 1956. Snow depths and ungulate abundance in the mountains of Western Canada. J. Wildl. Manage. 20:159-168.
- _____. 1957. Dammed waters in a moose range. Murrelet, January-April. p. 1-3.
- _____. 1958. Landform and caribou distribution in British Columbia. J. Mammal. 39:400-412.
- Edwards, R.Y. and R.W. Ritcey 1959. Migrations of caribou in a mountainous area in Wells Gray Park, British Columbia. Can. Field-Natur. 73:21-25.
- _____. 1960. Foods of caribou in Wells Gray Park, British Columbia. Can. Field-Natur. 74:3-7.
- Edwards, R.Y., J. Soos and R.W. Ritcey. 1960. Quantitative observations on epidendric lichens used as food by caribou. Ecology 41:425-431.
- Elliott, J., D.S. Eastman, D.F. Hatler and I. Hatter. (In preparation). Level Mountain/Horseranch Range wolf/caribou study.
- Environment and Land Use Committee (ELUC). 1974. Mica Reservoir Region resource study. Vol. 2. (Appendices). B.C. Min. Environ. Victoria, B.C.
- _____. 1980. Raft-North Thompson PSYUs logging-caribou study. Report of the Steering Committee. Victoria, B.C. 47 p.
- Environment and Land Use Sub-Committee on Northeast Coal Development. 1977. Northeast Coal Study preliminary environmental report on proposed transportation links and townsites. B.C. Min. Environ., Victoria, B.C. 141 p. + appendices.
- _____. 1978. Northeast Coal Study preliminary environmental report 1977-1978. B.C. Min. Environ., Victoria, B.C. 173 p. + appendices.
- Evans, H.F. 1964. Investigation of woodland caribou in the northwestern United States. Trans. N. Amer. Wildl. Conf. 29:445-453.
- Freddy, D.J. 1974a. Status and management of the Selkirk caribou herd, 1973. M.Sc. thesis. Univ. of Idaho, Moscow, Idaho. 132 p.
- _____. 1974b. Management guidelines for timber harvesting in caribou winter habitat in the southern Selkirk and Purcell Mountains. B.C. For. Serv., Nelson, B.C. Unpubl. report. 8 p.
- _____. 1974c. Timber harvest within Selkirk caribou winter habitat 1974-1994. Report to B.C. For. Serv., Nelson, B.C. 10 p.

- _____. 1979. Distribution and movements of Selkirk Caribou, 1972-1974. *Can. Field-Natur.* 93:71-74.
- Freddy, D.J. and A.W. Erickson. 1975. Status of the Selkirk mountain caribou. P. 221-227 In J.R. Luick, P.C. Lent, D.R. Klein, and R.G. White (editors). *Proc. 1st Int. Reindeer/Caribou Symp.*, 9-11 August 1972, Univ. of Alaska, Fairbanks, Alaska.
- Fuller, T.K. and L.B. Keith. 1980. Physical characteristics of woodland caribou in northeastern Alberta. *Can. Field-Natur.* 94:331-333.
- Gaare, E., A. Sørensen, and R.G. White. 1977. Are rumen analyses representative of the diet? *Oikos* 24:390-395.
- Geist, V. 1978. Behavior. Pp. 283-296 In J.L. Schmidt and D.L. Gilbert (editors), *Big Game of North America: ecology and management*. Wildlife Management Institute, Stackpole Books, Harrisburg, Pa. 494 p.
- Hamer, D. 1974. Distribution, abundance and management implications of the grizzly bear and mountain caribou in the Mountain Creek watershed of Glacier National Park, British Columbia. M.Sc. thesis. Univ. of Calgary, Calgary, Alta. 164 p.
- Hart, J.S., O. Heroux, W.H. Cottle, and C.A. Mills. 1961. The influence of climate on metabolic and thermal responses of infant caribou. *Can. J. Zool.* 39:845-856.
- Hatler, D.F. 1983. Studies of radio-collared caribou in the Spatsizi Wilderness Park area, British Columbia. Spatsizi Assoc. for Biological Research Report No. 2, Smithers, B.C. 102 p.
- Hatter, I. 1979. The woodland caribou of Northern Tweedsmuir Park. B.C. Min. of Lands, Parks and Housing, Parks and Outdoor Recreation Div., Victoria, B.C. 48 p.
- Hazelwood, W.G. 1975. Tweedsmuir Park initial wildlife and fisheries inventory 1975. B.C. Parks Branch, Victoria, B.C. Unpubl. report.
- Hazelwood, W.G. and J.A. MacKinnon. 1982. Ungulate values in the Rocky Mountain Trench: SBSH Biogeoclimatic Subzone. B.C. Min. For., Prince George, B.C. 111 p.
- Helle, T. and L. Tarvainen. 1984. Effects of insect harassment on weight gain and survival in reindeer calves. *Rangifer* 4:24-77.
- Herbison, B. 1973. Observations of mountain caribou in the Lardeau and Duncan Valleys, and north end of Kootenay Lake. Argenta, B.C. Unpubl. report. 12 p.
- Higgs, A.J. 1981. Island biogeography theory and nature reserve design. *J. Biogeogr.* 8:117-124.

- Hissa, R., S. Saarela and M. Nieminen. 1981. Development of temperature regulation in newborn reindeer. *Rangifer* 1:29-38.
- Hodson, K. 1977. A winter population and habitat survey in the Telkwa mountains of mountain caribou (*Rangifer tarandus montanus*), Jan - April, 1977. Fish and Wildlife Branch, Smithers, B.C. Unpubl. report. n.p.
- Holechek, J.L., M. Vavra, and R.D. Pieper. 1982. Botanical composition determination of range herbivore diets: a review. *J. Range Manage.* 35:309-315.
- Holland, S.S. 1964. Landforms of British Columbia, a physiographic outline. B.C. Dep. Mines and Pet. Res. Bull. 48. Victoria, B.C. 138 p.
- Hyvärinen, H., T. Helle, M. Nieminen, P. Väyrynen, and R. Väyrynen. 1977. The influence of nutrition and seasonal conditions on mineral status in the reindeer. *Can. J. Zool.* 55:648-655.
- Irving, L. 1966. Adaptations to cold. *Sci. Amer.* 214:94-101.
- Jerry, D. 1982. Old-growth management on the Idaho Panhandle National Forests. Paper presented at Symp. on Wildlife Relationships in Old-Growth Forests, Northwest Section, the Wildlife Society, 14-16 April, 1982. Juneau, Alaska.
- Johnson, D.H. 1980. The comparison of usage and availability measurements for evaluating resource preference. *Ecology* 61:65-71.
- Johnson, D.R. 1976. Mountain caribou: threats to survival in the Kootenay Pass region, British Columbia. *Northw. Sci.* 50(2):97-101.
- Johnson, D.R. and R.M. Feldman. 1979. Potential mountain caribou habitat: Selkirk Mountains, northern Idaho and northeastern Washington. Univ. of Idaho, Moscow, Idaho. Map 1:63,360.
- Johnson, D.R. and D.R. Miller. 1979. Observations on reproduction of mountain caribou. *Northw. Sci.* 53:114-117.
- Johnson, D.R., D.R. Miller and J.M. Peek. 1977. Guidelines for human activity within the range of mountain caribou, southern Selkirk Mountains. Forest, Wildlife and Range Exp. Stn. Misc. Publ. No. 3, Univ. of Idaho, Moscow, Idaho. 5 p.
- _____. 1981. Guidelines for human activity within the range of mountain caribou, southern Selkirk Mountains. Forest, Wildlife and Range Exp. Stn. Misc. Publ. No. 3, Univ. of Idaho, Moscow, Idaho. Revised. 7 p.
- Johnson, D.R. and M.C. Todd. 1977. Summer use of a highway crossing by mountain caribou. *Can. Field-Natur.* 91:312-314.
- Kamloops Forest Region. 1979. Okanagan Timber Supply Area yield analysis report. B.C. Min. For., Victoria, B.C. 101 p.

- _____. 1981. Kamloops Timber Supply Area yield analysis report. B.C. Min. For., Victoria, B.C. Revised April 1982. 60 pp.
- Kelsall, J.P. 1968. The migratory barren-ground caribou of Canada. Can. Wildlife Serv. Monogr. 3. Dep. Indian Affairs and Northern Development. Queen's Printer, Ottawa, Ont. 340 p.
- _____. 1975. Warble fly distribution among some Canadian caribou. P. 509-517 In J.R. Luick, P.C. Lent, D.R. Klein, and R.G. White (editors). Proc. 1st Int. Reindeer/Caribou Symp., 9-11 August 1972, Univ. of Alaska, Fairbanks, Alaska.
- Kelsall, J.P., E.S. Telfer and T.D. Wright. 1977. The effects of fire on the ecology of the boreal forest, with particular reference to the Canadian north: a review and selected bibliography. Can. Wildlife Serv. Occas. Pap. 32. 58 p.
- Klein, D.R. 1971. Reaction of reindeer to obstructions and disturbances. Science 173:393-398.
- _____. 1980. Reaction of caribou and reindeer to obstructions - a reassessment. P. 519-527 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- _____. 1982. Fire, lichens and caribou. J. Range Manage. 35:390-395.
- Langman, V.A. and C.R. Taylor. 1980. Nasal heat exchange in a northern ungulate: the reindeer (*Rangifer tarandus*). P. 377-378 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Layser, E.F. 1974. A review of the mountain caribou of northeastern Washington and adjacent northern Idaho. J. Idaho Acad. Sci., Spec. Res. Issue No. 3. 64 p.
- LeResche, R.E. 1968. Spring-fall calf mortality in an Alaska moose population. J. Wildl. Manage. 32(4):953-956.
- Low, W.A. 1964. A general ecological study of mountain caribou in Tweedsmuir Provincial Park, British Columbia. Report of Game Management Research Division for 1963. B.C. Fish and Wildlife Branch, Victoria, B.C. 4 p. (Cited by Hatter 1979).
- _____. 1965. A general ecological study of mountain caribou in Tweedsmuir Provincial Park, British Columbia. B.C. Fish and Wildlife, Branch, Victoria, B.C. Unpubl. report. 7p.
- _____. 1976. Parasites of woodland caribou in Tweedsmuir Provincial Park, B.C. Can. Field-Natur. 90:189-191.

- Mackie, R.J. 1983. Natural regulation of mule deer populations, P. 112-125 In F.L. Bunnell, D.S. Eastman and J.M. Peek (editors). Symp. on natural regulation of animal populations. Forest, Wildlife and Range Exp. Stn., Proc. No. 14, Univ. of Idaho, Moscow, Idaho.
- Maikawa, E. and K.A. Kershaw. 1976. Studies on lichen-dominated systems Part 19: The post fire recovery sequence of black spruce lichen woodland in the Avitau Lake region, Northwest Territories, Canada. Can. J. Bot. 54:2679-2687.
- Marshall, R. 1984. First progress report of the Tweedsmuir - Entiako caribou study: November 1983 - June 1984. B.C. Min. Environ., Fish and Wildlife Branch, Smithers, B.C. Unpubl. report. n.p.
- McCrory, W. 1978. Mountain goat and mountain caribou study, Glacier and Mount Revelstoke National Parks: progress report. Submitted to Parks Canada, Revelstoke, B.C. 13 p.
- _____. 1979. A brief concerning the endangered status of the mountain caribou in Glacier and Mount Revelstoke National Parks, B.C. Submitted to Parks Canada, Revelstoke, B.C. 6 p.
- McCrory, W. and B. Holland. 1977. Mountain goat and mountain caribou study, Glacier and Mount Revelstoke National Parks: progress report. Submitted to Parks Canada, Revelstoke, B.C. 23 p.
- McDonald, E.J. and A.M. Martell. 1981. Twinning and postpartum activity in barren-ground caribou (Rangifer tarandus). Can. Field-Natur. 95:354-355.
- McEwan, E.H. and P.E. Whitehead. 1970. Seasonal changes in the energy and nitrogen intake in reindeer and caribou. Can. J. Zool. 48:905-913.
- McMinn, R.G. 1982. Ecology of site preparation to improve performance of planted white spruce in northern latitudes. P. 25-32 In M. Murray, (editor). Forest regeneration at high latitudes. School Agric. and Land Resour. Manage. Misc. Rep. 82-1, Univ. of Alaska, Fairbanks, Alaska. 34 p.
- McNaughton, S.J. and L.L. Wolf. 1979. General ecology, second edition. Holt, Rinehart and Winston, New York, N.Y. 702 p.
- Miller, D.H. 1964. Interception processes during snowstorms. USDA For. Serv. Res. Pap. PSW-18.
- Miller, D.R. 1977. Observations of caribou and caribou environment in northern and southern Tweedsmuir Park and Wells Gray Park in summer of 1977 with comments on related observations in Spatsizi Park during spring. Submitted to B.C. Parks Branch, Victoria, B.C. Unpubl. report. 28 p.
- Mitchell, H.B. 1978. Bergerud's report. B.C. Fish and Wildlife Branch, Williams Lake, B.C. Unpubl. report. 3 p.

- Monteith, M. 1979. Logging/caribou relationships in the Raft-North Thompson: diameter limit logging. P. 28-31 In J. Dick (compiler). Workshop on logging/caribou relationships with specific reference to the North Thompson and Raft PSYU's. ELUC Sectretariat, B.C. Ministry of Environment, Victoria, B.C. 73 p.
- Munro, J.A. 1945. Preliminary report on the birds and mammals of Glacier National Park, British Columbia. Can. Field-Nat. 59:175-190.
- Neil, R.G. 1980a. Variables affecting timber harvesting proposals, Selkirk caribou range, Kootenay Lake TSA, Summit Creek Planning Unit. B.C. Min. For., Nelson, B.C. Unpubl. report. 7 p.
- _____. 1980b. Forest-mountain caribou research proposal, Selkirk caribou range, Kootenay Lake TSA. B.C. Min. For., Nelson, B.C. Unpubl. report. 5 p.
- Nelson Forest Region. 1980. Kootenay Lake Timber Supply Area yield analysis: discussion report. B.C. Min. For., Nelson, B.C. 43 p.
- _____. 1981a. Arrow Timber Supply Area yield analysis report. B.C. Min. For., Nelson, B.C. 41 p.
- _____. 1981b. Cranbrook Timber Supply Area yield analysis report. B.C. Min. For., Nelson, B.C. 48 p.
- _____. 1981c. Golden Timber Supply Area yield analysis report. B.C. Min. For., Nelson, B.C. 36 p.
- _____. 1981d. Revelstoke Timber Supply Area yield analysis report. B.C. Min. For., Nelson, B.C. 36 p.
- Nilssen, K.J. and T. Ringberg. 1980. Seasonal changes in body weight, food intake and thyroxine in free ranging and captive Svalbard reindeer, Rangifer tarandus platyrhynchus. P. 329-332 In E. Reimers, E. Gaave and S. Skjennberg, (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Osmond-Jones, E., L. Bonner, M. Sather, B. Smith and M. MacColl. 1975. A fisheries and wildlife survey of the Burnie Lakes Park proposal. B.C. Dep. of Recreation and Conservation, Parks Branch, Victoria, B.C. 44 p.
- Page, R.E. (In preparation). Caribou calf mortality in northwestern British Columbia M.Sc. thesis, Univ. of Victoria, Victoria, B.C.
- Palmer, K.A. 1981. Snags, live trees and epidendric lichens of the Interior Cedar-Hemlock and Engelmann Spruce-Subalpine Fir Zones, Blue River, B.C. Submitted to B.C. Min. For., Victoria, B.C. Draft.

- _____. 1982. Arboreal lichen cover and abundance in four ages of selective cut Engelmann Spruce - Subalpine Fir (Moist Subzone). Preliminary study. B.C. Min. For., Victoria, B.C. 51 p.
- Parker, G.R. 1981. Physical and reproductive characteristics of an expanding woodland caribou population (Rangifer tarandus caribou) in northern Labrador. Can. J. Zool. 59:1929-1940.
- Parminter, J. 1983. Fire-ecological relationships for the biogeoclimatic zones and subzones of the Fort Nelson Timber Supply Area. Northern Fire Ecology Project, B.C. Min. For., Protection Branch, Victoria, B.C. 128 p.
- Pearse, P.H. 1976. Timber rights and forest policy in British Columbia. Report of the Royal Commission on Forest Resources. Vol. 1. Queen's Printer, Victoria, B.C. 395 p.
- Peek, J.M. and D.S. Eastman. 1983. Factors which naturally control moose populations. P. 175-193 In F.L. Bunnell, D.S. Eastman and J.M. Peek (editors). Symp. on natural regulation of animal populations. Forest, Wildlife and Range Exp. Stn., Proc. No. 14, Univ. of Idaho, Moscow, Idaho.
- Petro-Canada. 1981. Monkman Coal Project Stage II report. Vol. 2. Environmental assessment. Prepared for the Coal Guidelines Steering Committee, Victoria, B.C.
- Pickett, S.T.A. and J.N. Thompson. 1978. Patch dynamics and the design of nature reserves. Biol. Conserv. 13:27-37.
- Pojar, J. 1983. Forest ecology. P. 221-318 In Forestry Handbook for British Columbia. 4th ed. Forestry Undergraduate Society. Faculty of Forestry, Univ. of B.C., Vancouver, B.C. 611 p.
- Prince George Forest Region. 1979. Prince George Timber Supply Area yield analysis report. B.C. Min. For., Victoria, B.C. 24 pp. + appendix.
- _____. 1980. McBride Timber Supply Area yield analysis report. B.C. Min. For., Prince George, B.C. 26 pp. + appendix.
- _____. 1981. Peace Timber Supply Area yield analysis report. B.C. Min. For., Prince George, B.C. 34 p.
- Prince Rupert Forest Region. 1981a. Bulkley Timber Supply Area report. B.C. Min. For., Prince Rupert, B.C. 52 p.
- _____. 1981b. Morice Timber Supply Area report. B.C. Min. For., Prince Rupert, B.C. 42 p.
- _____. 1981c. Lakes Timber Supply Area report. B.C. Min. For., Prince Rupert, B.C. 67 p.

- Reid, Crowther and Partners, Ltd. 1978. Report on Environmental Studies for the McGregor Diversion Project. Report prepared for B.C. Hydro and Power Authority, Vancouver, B.C.
- Reimers, E. 1980. Activity pattern; the major determinant for growth and fattening in Rangifer? P. 466-474 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Report of the Provincial Warden. 1905-1956. Annual reports of Provincial Warden Services, B.C. Fish and Wildlife Branch, Victoria, B.C.
- Revel, J. and B. Fraser. 1981. Silviculture policy and treatment guidelines for the Prince George Forest Region. B.C. Min. For., Prince George, B.C. 53 p + appendix.
- Ringberg, T., E. Reimers and R. Sørungaard. 1980. Growth and seasonal changes in organ weights and carcass composition in Svalbard reindeer (Rangifer tarandus platyrhynchus). P. 333-340 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway. 1979 Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Ritcey, R. 1952. Report on wildlife survey and research in Wells Gray Park, 1951. B.C. Fish and Wildlife Branch, Kamloops, B.C. Unpubl. report.
- _____. 1955. Abundance and fall distribution of caribou in Wells Gray Park. B.C. Fish and Wildlife Branch, Kamloops, B.C. Unpubl. interim report. 6 p.
- _____. 1956. Report on Tweedsmuir reconnaissance; summer 1956. Wildlife Section Report 58, B.C. For. Serv., Parks and Recreation Div., Victoria, B.C. 55 p.
- _____. 1964. Summary of caribou flight, July 27, 1964. B.C. Fish and Wildlife Branch, Kamloops, B.C. Unpubl. report. 10 p.
- _____. 1970. Caribou management and inventory in M.A. 12. B.C. Fish and Wildlife Branch, Kamloops, B.C. Unpubl. report. 8 p.
- _____. 1974. Caribou and forest management in British Columbia. Paper presented at Short Course for Foresters, Forest wildlife ecology and management, Vernon, B.C. Copy available from B.C. Min. Environ., Fish and Wildlife Branch, Kamloops, B.C. 10 p.
- _____. 1976. Caribou management plan: Region 3. B.C. Fish and Wildlife Branch, Kamloops, B.C. 15 p. + appendix.
- _____. 1979. Problem identification: Fish and Wildlife Branch. P. 3-5 In J. Dick, (compiler). Workshop on logging/caribou relationships with specific reference to the North Thompson and Raft PSYU's. ELUC Secretariat, B.C. Min. Environ., Victoria, B.C. 73 p.

- _____. 1980. Summer caribou census. B.C. Fish and Wildlife Branch, Kamloops, B.C. Unpubl. report. 6 p.
- _____. 1982. Summer caribou census - July 29 and 30, 1982. B.C. Min. Environ., Fish and Wildlife Branch, Kamloops, B.C. Unpubl. report. 7 p.
- Ritcey, R. and D.J. Low. 1975. Caribou census 1975. B.C. Fish and Wildlife Branch, Kamloops. Unpubl. report. 6 p.
- Russell, D. 1975. Mountain caribou project proposal. B.C. Fish and Wildlife Branch, Williams Lake, B.C. Unpubl. report. 6 p.
- Russell, D. and S. Russell. 1976a. Guide and trapper summaries, Quesnel Highlands, summer 1975. B.C. Fish and Wildlife Branch, Williams Lake, B.C. Unpubl. report.
- Russell, D. and S. Russell. 1976b. Habitat investigations of mountain caribou in the Quesnel Highlands, British Columbia. B.C. Fish and Wildlife Branch, Williams Lake, B.C. Unpubl. report.
- Russell, J., R.A. Demarchi and H.R. Jamieson. 1982. Mountain caribou in the Kootenay Region. Report prepared for the B.C. Fish and Wildlife Branch, Cranbrook, B.C. Preliminary draft.
- Safranyik, L. 1981. Spruce beetle biology and management. P. 3-4 In Proc. Spruce Beetle Management Seminar and Workshop, 7-8 October 1980, Prince George, B.C. B.C. Min. For., Pest Management Report No. 1.
- Schroeder, G.J. 1974. Arboreal lichens: a discussion of their importance in the management of the Selkirk caribou. A report to the International Caribou Study Steering Committee, 15 March 1974, Spokane, Washington. 12 p.
- Scott, M. 1982. Selkirk mountain caribou study. Idaho Dep. of Fish and Game. Draft research proposal. 18 p.
- _____. 1983. Caribou ecology July 1, 1982 to June 30, 1983. Idaho Dep. of Fish and Game Job Progress Report, Project No. W-160-R-10. 48 p.
- Scotter, G.W. 1962. Productivity of arboreal lichens and their possible importance to barren-ground caribou (Rangifer arcticus). Arch. Soc. Bot-Fenn. "Vanamo" 16:155-161.
- Simberloff, D.S. 1983. Island biogeographic theory and the design of wildlife refuges. Sov. J. Ecology (Engl. transl. Ekologiya) 13:215-225.
- Simpson, K. and K. Hebert. 1982. Progress report: grizzly - caribou study, Revelstoke, B.C. B.C. Min. Environ., Fish and Wildlife Branch, Revelstoke, B.C. Unpubl. report. 10 p. + appendix.

- Simpson, K., K. Hebert and G.P. Woods. 1984a. Critical habitats of caribou (Rangifer tarandus caribou) in the mountains of southern British Columbia. B.C. Min. Environ., Fish and Wildlife Branch, Nelson, B.C. Preliminary draft. 23 p.
- _____. 1984b. Mountain caribou (Rangifer tarandus caribou) ecology in the Columbia Mountains of British Columbia. B.C. Min. Environ., Fish and Wildlife Branch, Nelson, B.C. Preliminary draft. n.p.
- Smith, J.H.G. 1955. Some factors affecting reproduction of Engelmann spruce and alpine fir. B.C. Dep. Lands For., For. Serv. Tech. Publ. 43, 43 p. (Cited by Alexander 1974).
- Sopuck, L.G. and D.R. Carruthers. 1983. Movements and distribution of caribou in relation to the Quintette Coal Development. Interim report. Prepared for Denison Mines Ltd. by Renewable Resources Consulting Services Ltd., Sidney, B.C. 59 p.
- Sparks, D.R. and J.C. Malechek. 1968. Estimating percentage dry weight in diets using a microscope technique. J. Range Manage. 21:264-265.
- Staaland, P., D.F. Holleman, J.R. Luick, and R.G. White. 1982. Exchangeable sodium pool size and turnover in relation to diet in reindeer. Can. J. Zool. 60:603-610.
- Staaland, H., R.G. White, J.R. Luick, and D.F. Holleman. 1980. Dietary influences on sodium and potassium metabolism of reindeer. Can. J. Zool. 58:1728-1734.
- Stardom, R. 1975. Woodland caribou and snow conditions in southeast Manitoba. P. 221-227 In J.R. Luick, P.C. Lent, D.R. Klein, and R.G. White (editors). Proc. 1st Int. Reindeer/Caribou Symp., 9-11 August 1972, Univ. of Alaska, Fairbanks, Alaska.
- Stelfox, J.G. and J.A. Bindernagel. 1978. Caribou behavior in relation to human-elk-wolf influences: Jasper National Park, 1971-1974. Can. Wildlife Serv. Occ. Paper. 59 p.
- Stelfox, J.G. and Jasper Warden Service. 1974. The abundance and distribution of caribou and elk in Jasper National Park, 1971 to 1973. Can. Wildlife Serv. and National and Historical Parks Branch, Edmonton, Alta. 84 p.
- Stelfox, J.G., P. Kuchar, and J.A. Bindernagel. 1978. Range ecology of mountain caribou (Rangifer tarandus caribou) in Jasper National Park, 1971-1974. Can. Wildlife Serv. Rep. for Parks Canada, Edmonton, Alta. 121 p.
- Stevenson, S.K. 1979. Effects of selective logging on arboreal lichens used by Selkirk caribou. Fish and Wildlife Report No. R-2, B.C. Min. For. and B.C. Min. Environ., Victoria, B.C. 75 p.
- _____. (In preparation). Quantifying the abundance of arboreal lichens: a review of methods. B.C. Min. For. and Min. Environ., Victoria, B.C.

- Syrjälä, L., J. Salonen and M. Valtonen. 1980. Water and energy intake and nitrogen utilization in reindeer. P. 252-261 In E. Reimers, E. Gaare and S. Skjennaberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp. Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Theberge, J.B. 1976. Proposed resolution of land-use conflict between logging and caribou in the West Twin Creek - Ptarmigan Creek area, Prince George District, British Columbia. Unpubl. report prepared for B.C. Min. Environ., Ecological Reserves Section, Victoria, B.C. 11 p.
- Theberge, J.B. and S.M. Oosenbrug. 1977. Analysis of potential for an ecological reserve in the Telkwa mountains, British Columbia, to protect mountain caribou. Report prepared for B.C. Min. Envir. and Min. of Recreation and Travel Industry, Victoria, B.C. 90 p.
- Thomas, D.C. 1982. The relationship between fertility and fat reserves of Peary caribou. Can. J. Zool. 60:597-602.
- Thomas, J.W. (editor) 1979. Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. USDA For. Serv. Agric. Handbook No. 553. 512 p.
- Tomba, F.S. 1983. Status and management of wolves in British Columbia. P. 20-24 In L.N. Carbyn (editor). Wolves in Canada and Alaska. Can. Wildlife Serv. Report Series No. 45, Ottawa, Ontario.
- Trudell, J., R.G. White, E. Jacobsen, H. Staaland, K. Ekern, K. Kildemo and E. Gaare. 1980. Comparison of some factors affecting the in vitro digestibility estimates of reindeer forages. Pp. 262-273 In E. Reimers, E. Gaare and S. Skjenneberg (editors). Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799 p.
- Utzig, G. and L. Herring. 1974. Factors significant to high elevation forest management. B.C. For. Serv., Research Div. Victoria, B.C. 69 p.
- Van Daele, L.J. and D.R. Johnson. 1983. Estimation of arboreal lichen biomass available to caribou. J. Wildl. Manage. 47:888-890.
- Van Tighem, K., L. Gyug and M. Dyer. 1982. The ecological (biophysical) wildlife inventory of Mount Revelstoke and Glacier National Parks. Unpubl. report prepared for Parks Canada by Can. Wildlife Serv. 280 p.
- Viereck, L.A. and L.A. Schandelmeier. 1980. Effects of fire in Alaska and adjacent Canada - a literature review. U.S. Dep. of Interior BLM-Alaska. Tech. Report 6. 124 p.
- Wales, R.A., L.P. Milligan and E.H. McEwan. 1975. Urea recycling in caribou, cattle and sheep. P. 297-307 In J.R. Luick, P.C. Lent, D.R. Klein, and R.G. White (editors). Proc. 1st Int. Reindeer/Caribou Symp., 9-11 August 1972, Univ. of Alaska, Fairbanks, Alaska. 551 p.

- White, R.G. 1975. Some aspects of nutritional adaptations of Arctic herbivorous mammals. P. 239-268 In F.J. Vernberg (editors). Physiological adaptation to the environment. Intext Educational Publishers, New York, N.Y.
- Wilcox, B.A. 1980. Insular ecology and conservation. Pp. 95-117 In M.E. Soulé, and B.A. Wilcox, (editors). Conservation biology: an evolutionary-ecological perspective. Sinauer, Sunderland, MA. 396 p.
- Wood, C.S. and G.A. Van Sickle. 1983. Forest insect and disease conditions: British Columbia and Yukon 1982. Can. For. Serv. BC-X-239, Pacific Forest Research Centre, Victoria, B.C. 31 p.
- Yeo, Jeffrey 1977a. An evaluation of the vegetation of Upper Monk Creek, British Columbia. University of Idaho, Moscow, Idaho. Unpubl. report. 26 p.
- Yeo, Jeffrey 1977b. Vegetational analysis of potential mountain caribou habitat in northern Idaho and adjacent Washington. University of Idaho, Moscow, Idaho. Unpubl. report, 17 p.
- Young, J.A. and M.L. Beets. 1980. High elevation guidelines for timber harvesting within the Quesnel Highland of British Columbia to protect sensitive wildlife habitat. Cariboo Region Technical Report HP-80-1, B.C. Min. Environ., Fish and Wildlife Branch, Williams Lake, B.C. 27 p.
- Yousef, M.K. and J.R. Luick. 1975. Responses of reindeer, Rangifer tarandus, to heat stress. P. 360-367 In J.R. Luick, P.C. Lent, D.R. Klein and R.G. White (editors). Proc. 1st Int. Reindeer and Caribou Symp., 9-11 August 1972, Univ. of Alaska, Fairbanks, Alaska. 551 p.
- Yule, J. 1979. Comparative study of arboreal lichens within the winter range of the Selkirk caribou. Unpubl. report prepared for B.C. Min. For., Nelson, B.C. 47 p.
- Zhigunov, P.S. (editor). 1961. Reindeer husbandry. 2nd ed. U.S. Dept. of Commerce, Springfield, Va. (Transl. from Russian.) (Cited by Geist 1978.)

APPENDICES

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APPENDIX 1. Data and procedures for assessing population numbers and status in caribou-forestry study area, British Columbia.

To assess our current knowledge of caribou populations in the study area, all observations (Vol. 2, Appendix 1) and survey reports were reviewed intensively. Data involving actual sightings of animals were assembled into the various current management units (GMU's) by date. They were then examined both for potential duplication (the same group of animals counted more than once) and for potential addition (different groups counted over a short time period). Neither duplication nor addition were common, because most area-specific observations were widely separated in time. As a general rule, local counts more than three days apart were not considered additive; however, the distance and topography between them, and the season, were taken into consideration in such cases. In short, the decision to add or not to add the counts from two or more observations within a short time period was somewhat subjective, but not arbitrary. Where doubt existed it was more common to perform the addition, therefore results can be considered a liberal interpretation of the data.

The intent of this exercise was to generate figures for the largest number of animals that could be documented in each area both historically, for perspective, and annually since 1970, to show trend. Those figures, as tabulated in Table A.1, are taken at face value in discussions about population numbers and status in the text. Although groups of GMU's presumably related are indicated in Table A.1, no attempt was made to separate out duplications or attempt syntheses there. However, that has been done, where possible, in the text. Also, observations of tracks and sign were not included in the calculation of numbers in Table A.1, but were occasionally referred to in the text to temper or strengthen interpretations.

It is important to distinguish between the three types of observations designated in Table A.1 as a means of judging the reliability of the counts as indicators of population size. Most of the figures listed are based on single observations (one or more animals in a particular place at a particular time) made opportunistically and incidentally. Those are clearly the least reliable, since they are not accompanied by information on occurrence in the rest of the survey area. Multiple counts are considered somewhat more

reliable because they involve a larger area of coverage, although in most cases that is still small relative to the total GMU area. The multiple counts were occasionally a series of two or more single observations in a short time period, but were most often data arising from reconnaissance type survey flights. Census data, resulting from specific attempts to enumerate all of the animals in a particular area, are theoretically the most reliable, although a census done in the wrong way and/or at the wrong time can fail. Because the objective was to document the largest number possible with data in hand, a single observation of a group of (for example) 10 animals would take precedence over a census result of nine animals in Table A.1 listings, regardless of the area of coverage.

TABLE A.1. Highest counts and observations of largest groups of caribou in forestry-caribou study area, British Columbia, through August 1982

Years	Areas										
	South and Central Monashees					Shuswap					
	3-34	8-23	8-24	4-14	4-32	3-35	3-36	3-39	3-40		
	NO. OT ^a	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT		
pre-1960				3	S?						
1961-65									16 C2		
1966-70		27 M2							"9" C2		
1971			2 S2								
1972			11 S3						34 M5		
1973			1 S2		22 S2						
1974			2 S2								
1975						14 S5	18+ S6		16 C2		
1976							13 S5				
1977		3 S5		3 S2		1 S2			7 M5		
1978											
1979						6 S5	4 S2				
1980							6 S5				
1981						2 S5	4 S5		7 S5		
1982											

TABLE A.1. Continued

Years	Areas							
	South Purcells		South Selkirks		No. + Central Monashee		Central Rockies	
	No. OT ^a	No. OT	No. OT	No. OT	No. OT	No. OT	No. OT	No. OT
pre-1960								
1961-65								
1966-70								
1971								
1972								
1973								
1974								
1975								
1976								
1977								
1978								
1979								
1980								
1981								
1982								

TABLE A.1. Continued

Years	Areas									
	Central Selkirks									
	4-15	4-16	4-17	4-18	4-28	4-29	4-30	4-31	4-33	
	NO. OT ^a	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT	NO. OT
pre-1960										
1961-65										
1966-70										
1971			"60" M4			13 S5	26 S4	25+ S3		
1972						11 S5		8 S4		
1973								6 S1		
1974			3 S4			4 S3	12 S4	3 S5		
1975			12 S4		7 S4	6 S4	3 S4	2 S4		
1976			7 S2							
1977										
1978							4 S2			
1979										
1980										
1981										
1982										

TABLE A.1. Concluded

Years	Areas					
	Peace - Northern Rockies					
	7-19	7-20	7-21	7-22		
	NO. ^a OT ^b	NO. OT	NO. OT	NO. OT		
pre-1960						
1961-65						
1966-70		8	M5			
1971						
1972						
1973						
1974						
1975						
1976					57	M6 2 S6
1977	13 M4				15	M4 8 S4
1978	24+ M3	3	S4		35	M3 15 M5
1979	4 S2				27	M2
1980					5	S4
1981	2 S2				12	S1 25 M5
1982	3+ S2				7	M5 6 S5

^a Largest number of caribou accounted for in time period indicated. Quotation marks indicate estimates.

^b Type of observation (O) in 3 categories: S= single (the number of animals seen in unit indicated were all in one location at the same time); M= multiple locations (the total seen were in two or more locations in a short enough time period so that duplication was unlikely); C= census (number seen was the result of a specific attempt to enumerate all of the animals in a particular location). T= Time of year in which observation occurred, as follows: 1-21 May to 10 June, 2-11 June to 20 September, 3-21 September to 20 October, 4-21 October - 15 January, 5-16 January to 31 March, 6-1 April to 20 May.

^c Min. population estimates by Simpson (1982): raw data not available.

APPENDIX 2. Relationships among different administrative areas for wildlife management in British Columbia, 1956-57 through 1982-83. Only those units discussed in the present report on caribou are listed.

GMJA	MAC	GMAB	GMJA	MAB	GMAC
3-34	15	12	4-19	10	10
3-35	13	12	4-20d	11	11
3-36	13	13	4-21d	11	11
3-39	14	14	4-22	11	11
3-40	13	13	4-23	11	11
3-41	13	13	4-24	11	11
3-43	13	13	4-25	11	11
3-44	13	13	4-26d	11	11
3-45	12	17	4-27	10	12
3-46	12	17	4-28d	10	10
4-01	11	11	4-29	10	12
4-02	11	11	4-30	10	10
4-03	11	11	4-31	10	10
4-04	11	11	4-32	10	12
4-05	11	11	4-33	10	11
4-06d	11	10	4-34	11	11
4-07	10	10	4-35	11	11
4-08	10	10	4-36	9	11
4-09	10	10	4-37	9	11
4-14	10	10	4-38	9	12
4-15	10	10	4-39	9	12
4-16	10	10	4-40	9	12
4-17	10	10	5-02A	19	19
4-18	10	10	5-06	16	16

APPENDIX 2. Continued

GMJA	MAb	GMAC	GMJA	MAb	GMAC
5-10	18	4	7-06	20	20
5-11	17	4	7-07	20	20
5-12	18	18	7-08	20	20
5-15A	19	19	7-09	20	20
5-15B	19	19	7-12	22	02
5-16	19	19	7-16	21	20
6-01	22	20	7-17	20	20
6-02	22	20	7-18	20	20
6-04	22	20	7-19	28	18
6-09	25	20	7-20	28	21
7-01	20	20	7-21	28	21
7-02	9	20	7-22	28	21
7-03	20	20	7-23	21	20/21e
7-04	20	20	8-23f	5	9
7-05A	20	20	8-24f	5	9
7-05B	20	20			

aGMU = Game Management Unit - administrative units for wildlife, 1975-76 to present.
 bMA = Management Area - administrative units for wildlife, 1967-68 through 1974-75.
 cGMA = Game Management Area - administrative units for wildlife, 1956-57 through 1966-67.
 dGMU not wholly contained in GMA and/or MA indicated.
 eParts of GMA 20 and 21 became part of MA 20.
 fGMU's 8-23 and 24 were 3-23 and 3-24 prior to 1982-83.

APPENDIX 3. New studies

The following studies were initiated after we completed data collection for this report.

Region 5

Seasonal movements of caribou in the Itcha-Ilgachuz area

Principal investigator: Daryll Hebert, Fish and Wildlife,
Williams Lake, B.C.

Comparison of caribou ecology in logged and unlogged areas in the
Quesnel Highland

Principal investigator: Dale Seip, University of British Columbia,
Vancouver, B.C.

Region 6

Movements and habitat use of caribou east of Tweedsmuir Park

Principal investigator: Rick Marshall, Fish and Wildlife, Smithers, B.C.
Reports: Marshall (1984)

Region 7

Movements and distribution of caribou in relation to Quintette Coal Development

Principal investigator: R. Jakimchuk, Renewable Resources Consulting
Ltd., Sidney, B.C.

Reports: Sopuck and Carruthers (1983)

APPENDIX 4. Personnel contacted

R. Addison	Ministry of Forests, Victoria
T. Antifeau	Dept. of Animal Science, Univ. of B.C., Vancouver
R. Apps	Ministry of Forests, Burns Lake
M. Beets	Ministry of Environment , Williams Lake
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M. Bloomfield	Alberta Fish and Wildlife Division, Hinton
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2

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Woodland Caribou and Their Habitat in Southern and Central British Columbia

Volume 2

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October 1985

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APPENDIX 1. Caribou sightings by region

Notes:

M - males

F - females

J - juveniles (young of the year except as indicated)

T - tracks

TOT - total

Unclassified animals are included in totals.

Region 3

Summary of Information Sources

1	R. Ritcey
2-12	T. Antifeau flights
13-14	F and W flight
15-20	Phil Holman
21-34	F and W flights
35	F and W files
36-39	S. Macdonald
40-44	Ratchford and Perry R. folios
45-48	F and W files
49-50; 52	D. Low
51; 53-67	F and W files
68-71	T. and C. Crowley
72-74	T. Antifeau
75-96	F and W flights
97-101	CLI flights
102	F and W files, Region 7
103-104	CLI flights
105-157	T. Antifeau

Caribou Sightings:

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
83D	Nov 28/80	1	Hwy 5 1 mi S of Chappell Cr				T5+		R. Ritcey; tracks crossed hwy
82M	Feb 1/79	2	Raft Mt, Groundhog Mt, Bischoff Lakes				T		T. Antifeau flight; any tracks
82M	Feb 15/79	3	Cayenne Cr, W arm				T		T. Antifeau; concentration of tracks at edge of 2 new cutblocks
82M	Mar 2/79	4	Cayenne Cr, W arm				18	1981	T. Antifeau
82M	Mar 8/79	5	Between Bower and Dudgeon Crs				22		T. Antifeau; in parkland
82M)	Mar 18/79	6	Table Mt, Stevens Lks, Groundhog Mt, Bischoff L				T		T. Antifeau flight; any tracks
83D)			Groundhog Mt				4		T. Antifeau
82M	Mar 18/79	7	E of Sunset L				21		T. Antifeau
82M	Mar 18/79	8	Raft Mt, Miledge Cr,				T		T. Antifeau flight; any tracks
82M)	Mar 20/79	9	Groundhog Mt, Bischoff L				6		T. Antifeau
83D)			Ridge E of Chappel Cr				T		T. Antifeau flight; any tracks
83D	Mar 20/79	10	Raft R, Stevens L, Mt St						
82M)	Jan 9/79	11	Anne, Groundhog, Bischoff L						
83D)			Raft R, Stevens L, Smoke Cr, Groundhog Mt, Bischoff L				T		T. Antifeau flight; any tracks
82M)	Jan 18/79	12	WG Park, Raft, N Thompson						F and W survey flight; any or tracks
83D)									
82M)	Mar 29-	13	Bill Miner Cr (Region 5 - #88)				18		F and W survey flight
caribou			Anstey R				T6		Phil Holman; at least 10' snow
83D)	31/77		Ratchford Cr				T		P. Holman
93A)			Upper Ratchford L				T		P. Holman; concentration of tracks
93A)	Mar 29- 31/77	14							P. Holman; bedded on ice
82M	Apr /74	15							P. Holman; bull caribou shot
82M	Apr 24/74	16							
82M	Apr 24/74	17							
82M	Feb 5/75	18	Upper Ratchford L						
82M	Late Oct/	19	Pettipiece Pass				1		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82M	Late Oct/	20	The Fortynine Cr	1			1		P. Holman; bull caribou shot
82M	Jul 13/65	21	Fight L				10		F&W survey flight
82M	Jul 13/65	22	Spahats Cr				11		F&W survey flight
82M)	Mar 27/79	23	Raft, Battle Mts, Murtle						F&W survey flight; any caribou
830)			L, Lempriere Cr						or tracks
830	Mar 27/79	24	Headwaters Robina Cr				8		F&W survey flight
93A	Jul 23/75	25	Archer Cr				3	2070	F&W caribou/goat flight
93A	Jul 23/75	26	Licksillet Cr				16	65-6900	F&W caribou/goat flight
93A	Jul 23/75	27	Eagles Nest Peak				4	1980-2100	F&W caribou/goat flight
93A	Jul 23/75	28	Mt Huntley				1	2010	F&W caribou/goat flight
93A	Jul 23/75	29	NE of Buchanan Peak	1			1	1950	F&W caribou/goat flight
93A	Jul 23/75	30	E fork Goat Cr	1			2	2130	F&W caribou/goat flight
93A	Jul 23/75	31	E fork Goat Cr				2	1800	F&W caribou/goat flight
93A	Sep 1/75	32	Mt Huntley				4		F&W caribou/goat flight
830)	Jul 24-	33	Wells Gray Park						F&W/Parks survey; any caribou
93A)	26/80								or tracks
93A	Jul 24-	34	N end Clearwater R				18		F&W/Parks survey; any caribou
	26/80								or tracks
830	Nov/78	35	E of Murtle Lagoon				20		Bob Miller; 20 caribou at these
							6		2 sites, heading south
									S. Macdonald
82M	Winter/	36	Rocky Cr				6		S. Macdonald
	79-80						3		S. Macdonald
82M	Mar 2/80	37	N of Ratchford Cr				3		S. Macdonald
82M	Spring/79	38	Cotton and Ratchford Crs				15-		S. Macdonald (Ratchford Folio)
82L	Mar 2/80	39	S of Queest Mt				30		S. Macdonald (Ratchford Folio)
82M	Apr 20/74	40	Upper Ratchford Lks				2		S. Macdonald (Ratchford Folio)
							3-5		S. Macdonald (Ratchford Folio)
82M	Spring/81	41	NE of N Queest Mt				14		Perry River Folio
82M	Apr 20/74	42	Ratchford Cr				T		Perry River Folio; old tracks
82M	Mar 6/75	43	Rocky Cr				T		G. Bodman in letter to
82M	Jul/77	44	E of Perry R				T		Pat Martin
830	/61	45	Adolph Cr						F&W/Parks survey; any caribou
830)	Summer/70	46	Wells Gray Park						

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93A)	Summer/75	47	Wells Gray Park						F&W/Parks survey; any caribou
82M)									
83D	Aug 2/66	48	Eastern Wells Gray Park						Jack Godsey flight; any caribou
82M	Winter/78-79	49	NW of E Barriere R						Caribou reported to D. Low by loggers
82M	Late Fall/73?	50	N of Harp Mt				4		Reported by loggers; in logging slash
83D	Fall/81	51	Allan Cr				2		
93A	Jan/74 or 75	52	S end Clearwater L				4-5		
83D	Sep/78	53	Miledge Glacier	2			2		Reported by D. Low; on lake ice
83D	Mar/75	54	Mt St Anne						
83D	Mar/75	55	Between Pyramide and Serpentine Crs						
82M	Jan 30/78	56	Groundhog Mt				10		Total shown is for both obs. 54 and 55
82M	Feb 14/78	57	Groundhog Mt						Information incomplete
82M	Jan 30/78	58	Edge of Caribou Meadow						
83D	Feb 25/80	59	Upper Bone Cr				5	1677-1750	Helicopter skier report
82M	Nov 21/77	60	Mile 37 Tumtum Rd				T1		Balco reports
82M	Dec 12/77	61	Mile 38 Tumtum Rd				4		Balco reports
82M	Dec 30/77	62	Mile 40 Tumtum Rd				T		Balco reports
82M	Dec 20/77	63	Mile 7 Tumtum Rd				1		Balco reports
82M	Winter 75/76	64	E of Wire Cache						P. Holman, D. Low; repeated sightings of caribou in logging
82M	Fall/75	65	SW edge Tumtum L						F. Richter; caribou in low-elevation habitat
83D	72 & 74	66	Mouth of Miledge Cr						F. Richter; reported by D. Low; Caribou struggling in deep powder snow in cedar-hemlock forest
83D	Winter/78	67	Upper Finn Cr						Seen by M. Gall on x-country ski trip
82M	Summer/79	68	Headwaters Cotton Cr				4		T. and C. Crowley

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82M	Summer/79	69	E of Myoff Cr				T		T. and C. Crowley; many tracks
82M	Jun/77	70	N Quest Mt				1		T. and C. Crowley
82M	Winter/ 81-82	71	Four Mile Cr at 20 km				4		Reported to Crowleys by Art Shaw; seen several times by loggers
830	Dec 6/78	72	Hwy 5 at Lot 2636				4-5		Reported by T. Antifeau; caribou moved down to hwy then back upslope, also along pipeline ROW
830	Late Nov/78	73	Lot 2505 W of Hwy 5	1			3		Reported by T. Antifeau; seen by loggers on pipeline ROW
830	Jan 20/79	74	Hwy 5 at Chappell Cr				3-5		Reported by T. Antifeau; caribou temporarily "yarded" in cedar-hemlock flat
93A	Jul 12/65	75	Little Baldy	3			3	1920	F&W flight
93A	Jul 12/65	76	Bass Mt (Region 5-#89)		1		1	2010	F&W flight
93A	Jul 12/65	77	Junction Mt	9	1		10	1890	F&W flight
830	Jul 12/65	78	SW side Goat Peaks		3		3	1980	F&W flight
82M	Mar 31/67	79	W of Wolfenden					1430	F&W flight; sign in open meadow; caribou digging to water
830	Mar 31/67	80	Tukto Ridge	2	1	1	4	1920	F&W flight
830	Mar 31/67	81	S and W Mt St Anne				T	1680	F&W flight; abundant tracks
830	Mar 31/67	82	Headwaters middle fork Raft R				T	1740	F&W flight; abundant tracks
82M	Mar 31/67	83	5 mi E of Stevens Lks				T2		F&W flight; abundant tracks
82M	Mar 31/67	84	Headwaters E fork Ritchie Cr				T	1370	F&W flight; abundant tracks
82M	Mar 31/67	85	Meadows NE of Raft Mt		3	1	4	1980	F&W flight; abundant tracks
82M	Apr 3/70	86	N side Trophy Mt				T		F&W flight; abundant tracks
82M	Apr 3/70	87	E of Table Mt			4	11	1980	F&W flight; abundant tracks
82M	Apr 3/70	88	Centre Mt				T2		F&W flight; abundant tracks
82M	Apr 3/70	89	SE of Stevens Lks				T6	1890	F&W flight; abundant tracks
82M	Apr 3/70	90	W side top end Mad R				T4	1580	F&W flight; abundant tracks

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82M	Apr 3/70	91	Ridge between Mad R, N Thompson, N of microwave tower				T4-5	1770	F&W flight; abundant tracks
82M	Mar 30/72	92	S side Trophy Mt		2	2	6	1890	F&W flight; abundant tracks
82M	Mar 30/72	93	NE side Trophy Mt				11	1920	F&W flight; abundant tracks
82M	Mar 30/72	94	E side Battle Mt	1			10	1950	F&W flight; abundant tracks
82M	Mar 30/72	95	Ridge E of Fight L				T5		F&W flight; abundant tracks
82M	Mar 30/72	96	Ridge between Mad R, N Thompson, S of microwave tower			1	6	1770	F&W flight; lots of skidoo tracks on road
82M	Feb 28- Mar 7/68	97	Table Mt, Trophy Mt, Maxwell Cr, Bichoff L, E of Celista Mt, W of Perry R				T		CLI flight; any caribou tracks
82M	Feb 28- Mar 7/68	98	NE of Tumtum L				4		CLI flight
82M	Jan 28- Feb 2/70	99	Plateau E of Stevens L				2		CLI flight
82M	Jan 28- Feb 2/70	100	Raft Mt, plateau E of Stevens L				T		CLI flight; any caribou tracks
93A	Jan & Feb 69 & 71	101	Headwaters of Licksillet Cr				T		CLI flight; few tracks
83D	Summer 80 Dec/69	102	Between Mt Milton and Clemina				T6-8	1830	M. Vatamaniuck
83D	Jan & Feb/70	103	Plateau S of Murtle L				T		CLI flight; few tracks
83D	Jan & Feb/70	104	Angus Horne Cr				1		CLI flight; few tracks
82M	Apr 24/79	105	Avola Microwave Hill				T		T. Antifeau; many tracks (flight)
82M	Late Dec/ 78 early Jan/79	106	Upper Maxwell Cr				4(+)		Reported by loggers to T. Antifeau - a few caribou

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82M 83D	Nov 14/79	107	E of Table Mt, Strait Cr, Finn-Froth Crs SE Raft Mt				T		T. Antifeau; several areas of tracks (flight)
82M	Jan 16/80	108					7		T. Antifeau; (flight) tracks and sighting
82M	Mar 5/80	109	Macrae Cr, N Blue R, Finn Cr, S Shannon Ridge				T		T. Antifeau; several areas of tracks
82M	Mar 5/80	110	N of Finn Cr				5		T. Antifeau; flight sighting
82M	Jan 14/80	111	E side Groundhog Mt				T		T. Antifeau; (flight) many tracks
82M	Jan 21/80	112	Raft Mt, Thunder R				T		T. Antifeau; (flight) tracks
83D							7		T. Antifeau; (flight) tracks
82M	Mar 20/80	113	NE Battle Plateau				T4-5		Bob Miller; reported to T. Antifeau
82M	Nov 20/79	114	Berry Cr				2		T. Antifeau; walking along logging road
82M	Dec 11/79	115	Lower Berry Cr				4		T. Antifeau; flight observation
82M	Feb 14/80	116	N of Finn Cr				2		T. Antifeau; tracks along skid trail
82M	Jun 25/78	117	Upper Lion Cr				1		T. Antifeau; 1 calf sighted on Park Road
82M	Jun 27/78	118	Upper Lion Cr				T		T. Antifeau; 2-3 tracks along logging road
82M	Jul/78	119	Avola Ridge				T		T. Antifeau; several areas of tracks (flight observation)
82M	Mar 8/80	120	Faulkner Cr, Finn Cr, Wilkins Cr, N Blue R, Macrae Cr, Bone Cr S Shannon Ridge				T		T. Antifeau; (flight) many tracks
83D							T		T. Antifeau; tracks on snow patches (flight)
82M	Feb 25/80	121					1		T. Antifeau; one bull in alpine (flight)
83D	Jul 25/79	122	N Blue R, White R						
83D	Oct 12/79	123	E of Straight Cr						

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
83D	Dec 10/79	124	Peddie Cr				T2		T. Antifeau; (ground) tracks of 2 adult caribou around logging
83D	Nov 27/79	125	N Blue R				T		T. Antifeau; (flight) tracks
83D	Nov/79	126	N Side lower Gum Cr						Reported to T. Antifeau by road construction crew; several caribou fed on lichens from felled trees
83D	Feb 3/80	127	Thunder R				T		Reported to T. Antifeau by helicopter ski guides - few tracks
83D	Feb 6/80	128	Bone Cr				8		Reported to T. Antifeau by helicopter ski pilot
83D	Feb 12/80	129	N Blue R				T		Reported to T. Antifeau by helicopter ski pilot - few tracks
83D	Mar 5/80	130	Bone Cr				4		Reported to T. Antifeau by helicopter ski pilot
83D	Mar 24/80	131	Lempriere Cr				T		T. Antifeau; (flight) few tracks
83D	Apr 25/80	132	Mt Chappell Ridge				T		T. Antifeau; (flight) many recent tracks; in unburnt areas
82M	early Apr/79	133	Lion Cr-Park Rd				3+	1525	Keith Bloom, reported to T. Antifeau; fresh tracks on logging road
82M	Late Oct/78	134	Upper Finn Cr Valley				4-5	1130	Bruce Noble, reported to T. Antifeau; valley crossing downstream of Salmon Lake
82M	Jun 13/79	135	Upper Finn Cr				T2	1150	Ralph Ritcey and Al Frisby; tracks of adult and calf, cross logging road

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82M	Mid-Sep/79	136	W side TumTum L				T	800	Reported to T. Antifeau by loggers
82M	Late Sep/79	137	NW TumTum L				1	800	Reported to T. Antifeau by loggers; cross logging road, moving downslope
82M	Late Oct/79	138	Upper Stratton Cr				T	1650	Reported to T. Antifeau by Weyco; tracks of a few in mature SB timber and bogs
82M	Mid Nov/79	139	Lower Sunset cr				T	1350	Reported to T. Antifeau by CTP-loggers; many tracks moving downslope into Sunset Cr Valley
82M	May 20/80	140	Park Road				2	1670	Reported to T. Antifeau by loggers; 1 cow and newborn calf along road
83D	Early	141	Upper Froth Cr				T	1700	Reported to T. Antifeau by Bruce Noble
83D	mid-Jan/79	142	Lower Serpentine Cr				3	700	Reported to T. Antifeau by CN-rail crew; 3 unclassified seen along tracks
83D	mid-Jan/79	143	Allan Cr				T		Reported to T. Antifeau by Keith Bloom; many tracks
83D	early Mar/79	144	Thunder R				T		Reported to T. Antifeau by Bruce Noble; many tracks
83D	Late Oct/78	145	Mud Cr	T					Reported to T. Antifeau by local moose hunters; a few caribou tracks heading east along N side of Mud Creek
83D	mid-Sep/79	146	Froth Cr				T		Reported to T. Antifeau by Chuck McQueen; in lake and meadows of upper valley
83D	Oct 6/79	147	Miledge Cr valley				1		Reported to T. Antifeau by Steve Quinn; one cow along road

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
83D	mid Oct/79	148	Lebher Cr				1		Reported to T. Antifeau by loggers
83D	Mid Nov/79	149	Lower N Blue R valley				2	900	Reported to T. Antifeau by Frank Trenholm; 3 unclassified in Cedar-Hemlock Zone
83D	Late Nov/79	150	Upper N Thompson near Adolph				T	1000	Reported to T. Antifeau by Steve Pelton; a few tracks near N Thompson Road
83D	Nov 1/79	151	Upper N Thompson valley by Stormking Cr				T	1000	Reported to T. Antifeau by Frank Trenholm; at least 2 crossed N. Thompson road from SW and headed to N side of N Thompson Valley (Pleasant Creek)
83D	Nov 10/79	152	Confluence of N Blue R and Blue R				T	1040	Report to T. Antifeau by Bob Miller; tracks of a few from N Blue River valley
83D	Nov 15/79	153	Blue R valley between N Blue R and MacRae Cr				T	1070	Reported to T. Antifeau by Bob Miller; tracks of a group, appeared to cross Blue River from the N and heading up to Peddie Mt
83D	Early Dec/79	154	Upper N Thompson R valley near Adolph Cr				4-6	1000	Reported to T. Antifeau by loggers
83D	Dec 12/79	155	N Thompson Valley near Smoke Cr				2	680	Reported to T. Antifeau by Ron Peltier
83D	Early Mar/80	156	Lower Clemina Cr				T	900	Reported to T. Antifeau by Keith Bloom; a few tracks in timber near cutblock
83D	May 23/80	157	Upper Finn Cr near Salmon L				T		Reported to T. Antifeau by Bryan Faasse

Region 4

Summary of Information Sources:

1-11	Cranbrook F and W office files
12-17	Nelson F and W office files
18-22,24	T. and C. Crowley
23	Keith Simpson
25	Park Warden Service, Glacier National Park
26-37	McCrary and Holland (1977); McCrary (1978)
38-145	J. Harling and J. Snyder, Notre Dame University Caribou Study
146-152	F and W office files
153-165	International Mountain Caribou Tech. Committee files (IMCTC)
173-232	IMCTC files
166-172;	
233-250	Carlton (1982)
251;254-256	Russell <u>et al.</u> (1982)
252-253	CLI flights
257-278	International Mountain Caribou Technical Committee files
279-286	B. Herbison
287-288	CLI flights
289-294;299	R. Demarchi
294-298	B. Herbison
299-300	J. Snyder

Caribou Sightings:

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
83F	Jun 1/73	1	Hall Cr near Copper Mt lookout				T3-4		Ray Johnson, Grand Forks
82F	Jun 1/74	2	W slope Dominion Mt				2		Ray Johnson, Grand Forks
82G	Dec 12/81	3	5-Mile on Lumberton Rd		2	1	3	1220	Ken McLennan; locals say 6 caribou present in lodgepole pine
82F	Apr 30/80	4	Hellroaring and Angus Pass				18		Seen by Rolfe Ganong (OK Helicopters); reported by Bruce McLellan
82F	Oct 5/79	5	Headwaters Skookumchuck R	1	3	1	5		Gary Hansen (G-0); Bull rutting
82F	Sept 18/79	6	Headwaters Ridgeway Cr		2	2	17		Dennis Myocle and Bob Swan, Wms Lake
82F	Reported Jul 12/79	7	Baribeau Cr	1	7		8		Murray McCulloch, trapper; reported by W. Cibulka, CO
82F	May 21/78	8	Baribeau sulfur springs	1			9		Reported by R. Seaton, CO
82F	Jun 5/76	9	Baribeau Cr				4		M. Seaton; on first slide near springs
82F	Aug 17/75	10	S ridge Mt McKay	3			9		Neil Davidson (helicopter pilot)
82F	Jan/82	11	Noke Cr				19-22		Seen by loggers; reported by Doug Martin. Feeding on logging in SB basins
82K	May 10/78	12	27 mi N of Duncan Dam cutoff on Lardeau Rd				5		L. Fleck
82F	Jan 8/79	13	Headwaters Tillicum Cr	1	2	2	7		D. Mawdsley; reported by D. Campbell, CO
?	/78	14	Timber Berth 70, Olafson Cr				7		MOF; "in conjunction with logging"
82F	Mid Jan/76	15	Wooden Shoe L; Skelly Cr headwaters						B. Churchill
82F	Oct 29/76	16	Rose Pass at head Crawford Cr			2	11		Rod Silver; edge of old clearcut
82K	Jul 27/77	17	N slope Mt Wilkie (Mobbs Cr drainage)			1	4		
82M	Feb/82	18	Mouth of Kinbasket Cr				3		Reported to C. Schiesser by loggers

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82M	Summer/75	19	E of headwaters of Mica Cr				T		T. and C. Crowley
82M		20	Windy Creek						
82M	Summer/77	21	W of Liberty Cr						Movement route reported to C. Schlessner by long-time resident of Boat Encampment
82M	Summer/78	22	Goldstream R				2		T. and C. Crowley
83D	Late Nov/81	23	SW of Mica Dam				1		Reported to Crowleys by Pat Caywood
82N	Aug 10/74	24	Silent Pass				14		Keith Simpson; SB bench
82N		25	Glacier Nat'l Park and area				2		T. and C. Crowley
82N	Jul 23/77	26	1 km S of Bostock Pass				T1		Any caribou sighting; Park Warden Service
82N	Jul 23/77	27	1.5 km S of Carson Cabin				T		McCrorry 1977
82N	Jul 26/77	28	3 km N of Bostock Pass				1		McCrorry 1977; on gravel bars below slide
82N	Late Sep/77	29	Lake at head of Farm Cr	1			T1		McCrorry 1977; feeding in alpine
82N	Late Sep/77	30	Mountain Creek				T1		McCrorry 1977; feeding in alpine
82N	Late Sep/77	31	Mountain Cr				T1		McCrorry 1977; near grassy slides
82N	Aug 8/77	32	Copperstain Mt				T		McCrorry 1977; tracks all around
82N	Aug 8/77	33	Peak S of Copperstain				T		McCrorry 1977
82N	Aug 13/77	34	W side Caribou Peak				T		McCrorry 1977; subalpine meadows; abundant tracks
82N	Aug 13/77	35	Mile 20-24, Beaver R				T		McCrorry 1977; in mature CH and spruce forests
82N	Jul 19/79	36	Incomappleux near Bain Brook	1	1		T		McCrorry 1978; on river bar
82N	Sep 20/78	37	N of Silent Mtn				T		McCrorry 1978; at treeline

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82K	Late April/74	38	Cambourne, on road				T		P. Wilmot and B. Manson; caribou and sign seen often in last 2-3 years, especially on slides
82K	Jan/66	39	Staubert L				8		S. Davey; crossing ice
82K	Winter/66	40	Flats NW of Trout Lake				11		S. Davey; in big cedars
82K	Fall/73	41	Flats W of Trout L				4		S. Davey; on logging road
82K	Late Sep/70	42	3 mi S of Trout L City				3		S. Davey; shot by hunters
82K	Late May/71-73	43	Ferguson Cr				1-6		P. Wilmot and B. Manson; seen every spring
82K	Summer/69	44	Ferguson Flats			1	5		S. Davey
82K	Winter/74	45	Gainer Cr				6		S. Davey
82K	Winter/65	46	Gainer Cr				13		S. Davey
82K	Summer/65 or 66	47	Alicia Cr				T	910-1220	J. Macnicol; sign of many caribou
82K	Jun 27/74	48	Duncan R 2 mi N of Westfall		1	1	3		KFP staff; feeding on slide
82K	Jul 12/74	49	Duncan R 1 mi S of Laidlaw	1			1		KFP staff; in cedar-hemlock
82K	Aug/74	50	Head of Jinx Cr, Duncan Valley	2			2		J. Lawrence; on snow patches
82K	Nov 28/74	51	Hall Cr	4	3		7		R. Johnson
82K	Jun/73	52	Between Coot L and Duncan R						J. Isaacs; "some" caribou
82K	Nov/72 or 73	53	Between Duncan R and Lake Cr				5		D. Wagenigen
82K	Nov/67	54	Between Healy Cr and Fays Peak				T		K. Wyles; saw sign several years
82K	Summer/72	55	S of Fays Peak				T		A. Gauldrott
82K	Nov/72	56	Rady Cr						L. Bell; no # given
82K	May/69	57	Asher Cr						P. Wilmot; no # given
82K	Fall/66-71	58	Galena Bay				25-30		L. Hascharl; in cedar-hemlock

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82K	7/70 or 71	59	Halfway Cr				20		L. Hascharl; no season given
82K	Spring/70	60	1 mi past St. Leon Hotsprings				5		V. Skalk
82K	Summer/72	61	St Leon Hotsprings area	1	1	1	T2		V. Skalk
82K	Summer/72	62	St Leon Hotsprings area		1	1	2		V. Skalk
82K	Summer/72	63	St Leon Hotsprings area				12		V. Skalk
82K	Summer/72	64	St Leon Hotsprings area				6		V. Skalk
82K	Feb 5/74	65	St Leon Hotsprings area	1			1		V. Skalk
82K	Late Nov	66	Craig-Benson Crs				12	760- 1520	K. Wyles; seen every day while logging
	Late								
	Dec/73								
82K	Nov 1/70	67	Mobbs Cr				16		J. Isaacs; logging area
82K	Dec/70	68	Mobbs Cr				18	1220	D. Brenton; seen often
82K	Jun/74	69	Mobbs Cr				T		J. Isaacs
82K	Early	70	Gerrard-main road				T1		W. Freezin
	Winter/73								
82K	Nov/58	71	SE of Tenderfoot Cr				2		J. Isaacs
82K	Fall/60-67	72	SE of Tenderfoot Cr				1-6		K. Bowles; hunted every fall
82K	Mar/73	73	SE of Tenderfoot Cr				T		D. Brenton; in spruce-balsam
							8-10		
82K	Fall/72	74	Lardeau R (Mile 28)				T		P. Remple
82K	Fall/73	75	Lardeau R (Mile 28)				T		J. Fenger
82K	Nov 29/74	76	Lardeau R near Poplar Cr				3		R. Johnson
82K	Aug/66	77	Tenderfoot 1 area				26		K. Wiles
82K	Sep/70	78	N fork of Kuskanax				25-		L. Hascharl; rutting area;
	or 71						30		25-30 shot after N Fork fire, when road opened
82K	Fall/67	79	Nakusp Hot spring				5-6		V. Skalk; 3 shot by old springs
82K	Summer/70	80	W of 2nd N Fork of Kuskanax				6		E. Neubrand; in alpine
82K	Jul/74	81	2nd N Fork of Kuskanax				T1		NDU caribou study
82K	Jul/74	82	Junction of Kuskanax and 2nd N Fork				T2		NDU caribou study
82K	May 9/75	83	Junction of Kuskanax and 2nd N Fork				T1		NDU caribou study

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82K	May 9/75	84	S forks of Kuskanax				T		NDU caribou study; 6 locations
82K	Nov/73	85	Headwaters of Poplar Cr				1		G. Kennedy
82K	Summer/74	86	Upper Poplar Cr				?		NDU caribou study; 2 locations
82K	Summer/74	87	Headwaters, E Fork Kuskanax				?		NDU caribou study; 2 locations
82K	Summer/74	88	Bremner-Poplar pass				T		NDU caribou study;
82K	Aug/73	89	S fork Poplar Cr				T		K. Wyles; sign often seen in summer
82K	Jun/70	90	Poplar Cr forks				T		K. Wyles
82K	Jul/74	91	Between Poplar and Cascade Crs				T1		KFP staff
82K	May 9/75	92	Bremner Cr				T		NDU caribou study; 2 locations
82K	Oct-Jan/67	93	Wilson L				60		L. Hascharl; usually 10-15 animals winter there
82K	Winter/73	94	Bremner Cr - Little Wilson L						J. Dorbit(?); plowed logging road and saw "quite a few"
82K	Fall/73	95	Bremner cr				T		Interview #141; 2 locations
82K	Mar/74	96	E of Kimbol L				T20		NDU caribou study
82K	Mar/74	97	Hemling L				T6		NDU caribou study
82K	Winter/75	98	S of Hamling L				5		NDU caribou study
82K	Winter/75	99	E of Kimbal L				T6		NDU caribou study
82K	Winter/73	100	Ridge NE of Box L				3		C. Hamling; had never seen caribou there before
82K	Fall/71	101	Between Wilson and Box L				4		C. Hamling; in burn, shot 4
82K	Dec 5-6/74	102	Between Summit and Slocan L				T		B. Jamieson and J. Russell
82K	Dec /73	103	Between Summit and Slocan L				4		Interview #141
82K	Jul/65	104	Meadow Mt				1		E. Alexander; in alpine meadow
82K	Summer/65	105	Between Meadow and John Cr				1		J. Fenger; saw 1 caribou every summer
82K	Mar/74	106	Ridge W of Lake Cr				T		NDU caribou study
82K	Mar/74	107	Howser Ridge				5		NDU caribou study
82K	Lt fall/70	108	Howser Ridge				T		J. Raper; many tracks

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82K	Fall/67	109	Duncan L S of Dunn Cr				1		G. Seamark; dead caribou in flooded reservoir
82K	Sep/to 67	110	Duncan Meadows						J. Isaacs; saw and hunted caribou here every fall until flooding
82K	Aug/73	111	Ridge N of Sluicibox Cr				T		J. Bekker
82K	Mar/74	112	Upper Howser, Rory Crs				T		NDU caribou study
82K	Sep/68	113	S Fork Fry Cr; 13 mi				1		G. Seamark and P. Trotter; on trail
82K	Summer/69	114	Duncan L Road, N of Glacier Cr				2		I. Galbraith
82K	Spring/70	115	Fry Cr point				T		C. Petersen
82K	Winter/70	116	NE of Johnson's Landing						J. Macnicol; no #
82K	Winter/70	117	Between Mt Willet and Fry Cr						J. Macnicol; no #
82K	Nov-Dec/75	118	Mouth of Hall Cr				9		F. Zymer; thinks these animals moving W to winter on Howser Ridge
82K	Nov-Dec/75	119	Mouth of East Cr				3-4		F. Zymer
82K	Nov-Dec/75	120	Mouth of Sob Cr				T		F. Zymer
82K	Nov-Dec/75	121	Mouth of Cockle Cr				T		F. Zymer
82K	Jan/73	121	Between Benson and Hobbs Cr				4		R. Boden; fresh cedar-hemlock logging
82K	Jan/74	122	Duncan R at East Cr				T		R. Boden; caribou and moose both
82K	Jan/67-68	123	Cascade Cr				T3		R. Boden; small bands seemed to be moving through
?	Nov/74	124	Near Naksup Hot Springs				2		P. Ewart; 2 shot
82K	Jun/72	125	Headwaters of Isaac Cr, 14 mi S of Revelstoke				5		"Game warden Morgan and William Durram" "5 white caribou"
82K	Oct-Nov/74	126	Wilson L				12		G. Olson; feeding in cedar-hemlock
82K	May/75	127	Brenner Cr	2	2	1	5		G. Olson; feeding on slide

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82K	Nov/68 or 69	128	N. side Halfway Cr (13 mi)				20		G. Olson; in cedar-hemlock
82K	Nov/71	129	Halcyon Ridge				8		G. Olson; shot 1 bull
82K	69 or 70	130	Lakes N of Halfway Cr						G. Olson
82K	Nov/73	131	Kuskanax	2			2		G. Olson; fresh snow on road
82K	Aug/71	132	1st N fork of Kuskanax				?		G. Olson; caribou were in area as soon as the fires were out
82K	Lt May/75	133	Hamling L				T		R. Wrangle (Triangle Pacific)
82K	May/74	134	Upper Kuskanax				1		G. Olson; on slide
82K	Oct/71	135	Beaver 1				4		G. Olson; in cedar-hemlock swamp
82K	Feb-Mar/70-75	136	Halcyon Hot Springs				?		G. Olson; in cedar-hemlock swamp; not into sulfur but into the area above road
82K	Aug/71	137	Halfway Cr S side (13 mi)				?		G. Olson; licking sulfur
82K	Early Winter/71	138	Main road by Gerrard				11		W. Fregin
82K	Jun 12/75	139	Bremner Cr				7		NDU caribou study flight; on slide
82K	Jun 12/75	140	Bremner Cr				2		NDU caribou study flight; on slide
82K	Mar/74	141	Silvercup Ridge				T		Interview #143
82F	Sep/73	142	Ridge S of Houghton Cr	2	11		13		J. Oliver
82F	Winter/73	143	Head of Crawford Cr				7-9		L. Johnson; came down end of Nov to cedar/hemlock; went back up middle of Jan when snow hard
82F	May/75	144	End of Canyon Cr Road				8-10		L. Johnson?
82F	Aug/74	145	LaFrance Cr				12-14	1980	E. Denny; in spruce-balsam
82F	Nov 25/76	146	Just W of Salmo-Creston Summit	1	3	4	8		W. Van Velzen, Nelson
82F	Nov 29/76	147	Salmo-Creston summit, 1 mi E of microwave road	1	4	4	9		R. Kerr, Parks Branch
82F	Jun 9/78	148	1/2 mi E of S-C summit		1	1	2		Phoned in to Rod Silver

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Jun 29/78	149	Salmo-Creston				1		R. Roy
82F	Nov 11/76	150	1/2 mi E of S-C summit			1	4		
82F	Nov 12/76	151	Camera location E of summit	2		1	13		
82F	Nov 20/76	152	1/2 mi E of S-C summit	1		2	9		
82F	Oct 9/75	153	Carolina-N Summit Cr	1	1	1	13		D. Miller
82F	Oct 11/75	154	1/2 mi N of Bridal L		1	1	2		D. Miller
82F	Oct 11/75	155	Monk-Stagleap Summit				14		D. Miller
82F	Oct 19/75	156	Monk-Stagleap Summit				1		D. Miller
82F	Oct 24/75	157	Upper Curtis Creek	1	5	1	7		D. Miller; rutting group
82F	Oct 9/75	158	Salmo-Creston summit		1		11		D. Miller
82F	May 27/76	159	Carolina Cr				6	1520	D. Miller; included 1 pregnant female
82F	Jun 1/76	160	Carolina Cr		1		1	1400	D. Miller; probably not pregnant
82F	Jun 10/76	160	Carolina Cr	1			1	1370	D. Miller
82F	Sep/75	161	Hidden Cr				3		B. Gay; lots of tracks in balsam
82F	Oct 29/75	162	Lost Cr	1			1		B. Gay; big rack
82F	Nov 4/75	163	Lost Cr clearcut	2	3		5		B. Gay
82F	Apr 18/76	164	1 mi E of S-C summit				15		D. Flegal
82F	May 14/76	165	6 1/4 mi up Blazed Cr Road from Hwy 3				"50"		A. Horvath; "about 50"
82F	Oct 14/81	166	Gravel pile at Salmo-Creston Summit				14-5	1800	J. Carlton
82F	Oct 21/81	167	6 mi E of S-C summit	1	3		4	1460	T. Sterling; bull mounted cow
82F	Nov 9/81	168	Gravel pile at S-C summit				6	1800	T. Martin and B. Pellig; licking surface around gravel pile
82F	Nov 23/81	169	Hwy 3 at Char Cr				6	1340	B. Pellig and A. Elliott; licking salt on hwy
82F	Dec 15/81	170	Upper Summit Cr	1			1	1680	Loggers at timber sale
82F	Jan 5/82	171	Upper Summit Cr	1			1	1710	P. Hoar and J. Carlton; yearling bull with part of L front leg off; destroyed by R. Hoar

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Jan 6/82	172	1/4 mi S of Waldie L				1	1830	P. Harrington
82F	Mar 11/81	173	N Fork Summit Cr and Hwy 3	2			2		D. Chadwick; 2 bulls Licking road
82F	Mar 18/81	174	N Fork Summit Cr and Carolina Cr		3	3	8		D. Chadwick and K. Sumanik
82F	Jul 22/81	175	Upper Carolina Cr	3	1		9		B. Summerfield and D. Jerry
82F	Jul 23/81	176	Salmo-Creston summit	1			1		B. Summerfield and D. Jerry
82F	Sep 23/81	177	Upper Carolina Cr	1	1		2		M.R. Cutler, R. Wheeler, D. Fragness
82F	Dec 26/79	178	2 mi W of S-C summit	1	2	1	4		S. Chursinoff
82F	Mar 22/80	179	N Fork Summit Cr				"19"		N. Welden; "about 19 animals"
82F	Mid Apr/80	180	N Fork Summit Cr		4	2	6		H. Tschachne
82F	Apr 20/80	181	1 1/2 mi E of S-C Summit				3		H. Tschachne
82F	Apr 28/80	182	N Fork Summit Cr	1	6	2	10		V. Osborne
82F	Oct 2/80	183	Silver L near S-C summit	1			1		P. Stent; bull with lower jaw shot away (destroyed Oct 12 near Waldie L)
82F	Sep 15/80	184	N Fork Summit Cr	2	2	1	5		R. Neil
82F	May 11/74	185	Blazed Cr S of Darkwoods				8		Darkwoods Forest staff
82F	May 1/74	186	1/2 mi S of S-C Summit				7		Darkwoods Forest staff
82F	May 22/74	187	N Fork Summit Cr				1		Darkwoods Forest staff
82F	May 22/74	188	Blazed Cr within Darkwoods				T5-6		Darkwoods Forest staff
82F	Jun 2/74	189	Salmo-Creston Summit				2		Darkwoods Forest staff
82F	Jun 4/74	190	Caribou Pass in Darkwoods				T4-5		Darkwoods Forest staff
82F	Jul 10/74	191	N Fork Summit Cr				2		Darkwoods Forest staff
82F	Jul 23/74	192	1/2 mi W of S-C summit				3		Darkwoods Forest staff
82F	Oct 28/74	193	Elmo Cr, Block 13				T1		Darkwoods Forest staff
82F	Jun 9/74	194	Upper Next Cr				T1		Darkwoods Forest staff
82F	Jun 19/75	195	Upper Next Cr bridge				T1		Darkwoods Forest staff
82F	Jul 4/75	196	Caribou Pass				T1		Darkwoods Forest staff
82F	Jul 7/75	197	1/2 mi E of S-C summit	4			4		Darkwoods Forest staff
82F	Feb/76	198	Upper Hidden Cr				20-		Report of trapper
							25		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Jun 13/76	199	Porcupine Pass				2		Darkwoods Forest staff
82F	Oct 29/76	200	1/2 mi W of S-C summit	1			1		Darkwoods Forest staff
82F	Dec 29/76	201	Hidden Cr				15		Darkwoods Forest staff
82F	Dec 30/76	202	Hidden Cr	1		4	11		Darkwoods Forest staff
82F	Lt Dec/76	203	Hidden Cr				"26"		Darkwoods Forest staff
82F	Nov 12/77	204	Hidden Cr				7		Report of trapper
82F	Jul 30/79	205	N Fork Summit Cr		4	2	6		Darkwoods Forest staff
82F	Feb 23/78	206	N Fork Summit Cr	1	6	2	15		Darkwoods Forest staff
82F	Apr 7/78	207	W side Snowy top	2			2		G. Frew and R. Scheer
82F	Apr 7/78	208	Head of Seeman Cr				2		K. Sumanik, J. Peek, U. Johnson
82F	Apr 7/78	209	E side of Elmo L				1		K. Sumanik, J. Peek, D. Johnson
82F	Feb 25/78	210	N Fork Summit Cr				1		K. Sumanik, J. Peek, D. Johnson
82F	Jun 12/78	211	E side S-C summit				12		R. Silver
82F	Jul 15/78	212	Monk Cr Rd, Mi 32-33	2			3		W. Stowman
82F	Aug 3/78	213	N Fork Summit Cr		1		3		S. Stevenson
82F	Aug 4/78	214	Carolina Cr		1	1	2		S. Stevenson and R. Kerr
82F	Aug 8/78	215	N Fork Summit Cr		1	1	2		R. Kerr
82F	Aug 9/78	216	5 mi up Carolina Cr		1	1	2		R. Kerr
82F	Aug 9/78	217	Spur 8, Monk Cr Rd		1	1	2		F. Niven and A. Warner
82F	Aug 29/78	218	N Fork Summit Cr		1	1	2		G. Frew
82F	Early	219	W side S-C summit	1			"30"		B.C. Hydro worker
	Nov/78						1		P. Archibald
82F	Nov 2/78	220	W side S-C summit				1		B. and M. Frew
82F	Nov 5/78	221	W side S-C summit	1	2		5		D. Demchuk
82F	Nov 18/78	222	2 mi W of S-C summit		1	1	2		G. Frew
82F	Nov 24/78	223	W side S-C summit	1	5	3	9		K. Sumanik, G. Hartman
82F	Jan 16/78	224	N Fork Summit Cr		3	2	5		V. Osborne
82F	May 30/78	225	Carolina-Bayonne junct	1	2	1yr	4		V. Osborne
82F	Mar 28/78	226	N Fork Summit Cr				16		J. Tremblay
82F	Dec 15/78	227	1/2 mi W S-C summit				4		S. Neil
82F	Dec 11/78	228	1/2 mi W S-C Summit	2	4	3	9		R. Silver
82F	Jun 14/79	229	Salmo-Creston summit	3			3		K. Sumanik
82F	Jun 15/79	230	1/2 mi E S-C Summit				4		D. Gould
82F	Jul 4/79	231	Salmo-Creston summit	3	5	1	9		Schultz and Dury

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Aug 3	232	Near Snowy Top L	2			2		
82F	and 5/79 Feb 18,	233	5-6 mi W of Salmo- Creston Summit				8	1010- 1070	J. Tweedy; conifer habitat with deciduous underbrush
82F	Mar 19/82	234	N Fork Ridge				T3-4	1920	J. Tweedy
82F	Apr 1/82	235	Salmo-Creston summit				T1	1830	J. Tweedy
82F	Apr 3/82	236	Salmo-Creston summit	1			1	1800	J. Tweedy; appeared to be licking gravel behind gravel pit
82F	Apr 23/82	237	.7 mi E of S-C summit				5	1770	L. Fransson
82F	Apr 26/82	238	N Fork Summit Cr basin		4	2	8	1710- 1830	J. Carlton; same animals observed in 3 locations during the day
82F	Apr 26/82	239	Summit Cr Ridge					1710- 1830	J. Carlton; same animals observed in 3 locations during the day
82F	Apr 26/82	240	. 7 mi E of S-C summit					1710- 1830	J. Carlton; same animals observed in 3 locations during the day
82F	May 8/82	241	N Fork Summit Cr		3		14	1460	Reported to G. Woods
82F	May 17/82	242	N Fork Summit Cr				T3	1460	J. Carlton
82F	May 18/82	243	Salmo-Creston summit				T3	1800	J. Carlton
82F	May 22/82	244	Caroline Cr				T2	1615	J. Carlton
82F	May 23/82	245	Between S-C summit and Monk Cr				T3	1830- 1980	J. Carlton
82F	Mar 22/82	246	Summit Cr ridge	3			5	1950	J. Carlton, . Hair, R. Summerfield
82F	Mar 22/82	247	S of Devil's Hole L				T1	2042	J. Carlton, . Hair, R. Summerfield
82F	May 17/82	248	N Summit and Char Cr ridges				T		J. Carlton and others; many tracks
82F	May 17/82	249	Carolina Cr basin				T2		J. Carlton and others; many tracks
82F	Jun 8/82	250	Around lake in Cultus Cr				T2		J. Carlton, P. Harrington, R. Summerfield

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Fall/74	251	Alry Cr				T2		E. Kania in Russell et al. 1982
82K	Feb 6-10 /68	252	St Leon Cr				6		CLI flight
82K	Feb 6-10 /68	253	St Leon Cr				3		CLI flight
82M	May 24/72	254	Junction Downie and Sorcerer Crs				"40"		B. Dean; "about 40" cows and yearlings; in Russell et al. 1982
82N	Jun/73	255	Near Blackwater L				8		Forest Service staff; in Russell et al. 1982
82N	Summer/74	256	Ridge between Chatter Cr and Bush L				sign		Forest Service staff; in Russell et al. 1982
82F	Apr 1/76	257	.4 mi E of S-C summit				20		Russell et al. 1982
82F	Apr 10/76	258	1/2 mi E of S-C summit				19		D. Gray
82F	Apr 15/76	259	N Fork Summit Cr				uncertain number		G.F. Kenyon
82F	Apr 18/76	260	1 mi E of S-C summit				15		D. Gray
82F	Apr 21/76	261	1/2 mi E of S-C summit				14		Highways Dept staff
82F	Apr 26/76	262	N Fork Summit Cr				19		D. Gray
82F	Apr 28/76	263	N Fork Summit Cr				17		Highways Dept staff
82F	May 13/76	264	Lost Cr-N Summit divide; Carolina Cr-N Summit Ridge				T		D. Lyon
82F	Nov 25/76	265	W side Kootenay Pass	1	3	4	8		W. Van Velzen
82F	Nov 29/76	266	W side Kootenay Pass	1	4	4	9		R. Kerr
82F	Dec 11/76	267	N Fork Summit Cr				10		G. Bloor
82F	Jan 15/77	268	Headwaters Hidden Cr	2		4	18		R. Thomas
82F	Apr 26/77	269	W side Kootenay Pass				4		P. Shrieves
82F	May 13/77	270	W side Kootenay Pass				1		R. Scheer
82F	May 30/77	271	N Fork Summit Cr				2		R. Dillabaugh
82F	Aug 25/77	272	Hidden Cr				3		R. Thomas
82F	Sep 24/77	273	2 mi W of Kootenay Pass		1		1		D. Gray; mature cow illegally shot
82F	Oct 18/77	274	Hidden Cr	1			6		R. Thomas; rutting band

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Oct 21/77	275	1/2 mi W of Bridal L				17		W. Cumming
82F	Nov 5/77	276	2 mi E Kootenay Pass	1	1	1	3		R. Kerr
82F	Nov 15/77	277	1/4 mi W Kootenay Pass	2		1	8		Pew and Silver
82F	Nov 22/77	278	2 mi E Kootenay Pass				1		H. Nyst
82K	May/75	279	Mouth of Geigerich Cr		2	1	3		KFP employees; reported by B. Herbison
82K	Fall/75	280	Hall Cr at Duncan Road				15		KFP employees; reported by B. Herbison; came down Hall Cr and headed down Duncan River
82K	Mar/77	281	Just S of East Cr				14-5		KFP employees; seen from air in scrub timber
82K	Early Oct/77	282	Duncan Rd at Westfall R				T		KFP employees
82K	Mid-May/78	283	Mouth of Hume Cr				T		KFP employees
82K	Early Sep/78	284	Mouth of Hall Cr			1	1		KFP employees
82K	Oct/78	285	Mouth of Hume Cr				9		KFP employees; caribou crossed from W to E side of Duncan R
82K	Oct or Nov/78	286	Mouth of Hume Cr	1			1		KFP employees
82M	Feb 28-	287	Ridge N of Bignmouth Cr				T		CLI flight; few tracks
82M	Mar 7/68	288	Liberty Cr				T		CLI flight
82F	Apr 25/82	289	1.5 km E of Salmo-Creston summit		5	2	8		W.G. Smith
82F	Dec/76	290	Meadow Mt; N side Perry Cr				1		M. Guido
82F	Dec/83	291	Meadow Mt; N side Perry Cr				8		M. Guido
82F	Mar/84	292	E Hellroaring Cr				2		B. Warkentin

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82F	Jul 14/84	293	Headwaters Angus Cr	2	4	4	10		D. Basabara; photograph
82K	May/83	294	Doctor Cr				6		G. Engstrom
82K	May/83	295	Upper Dunn Cr		3		3		S. Toporowski; 3 cows on snowfield
82K	Jul/83	296	Duncan Rd between Westfall R and Stevens Cr	1			3		R. Honkenin
82K	May/84	297	Houston Cr						R. Honkenin; several cows and 1 good-sized bull
82K	Jun/84	298	Kootenay Joe Mt						M. Davidson
82G	Feb/84	299	Mt Olson; headwaters Yahk R		3	1	5	1800	S. Pearson; photograph
82F	Aug 3/74	300	N fork of Poplar Cr, below Tenderfoot Glacier (not mapped)				16		J. Snyder; on snow patch
82F	May/78	301	N of Hamling Lakes (not mapped)				6		J. Snyder; in ESSF zone

Region 5

Summary of Information Sources:

1-11	Caribou map drawer, F and W
12	Any late winter sightings or tracks - Russell and Russel maps
13-14	Later additions to Russell and Russell maps
15-30	Caribou inventory files, F and W
31-44	Aerial Survey files
45-49	Hazelwood (1975)
50-55	Miscellaneous
56-62	Doug Merrick and other Quesnel District MOF staff
63-78	Maps prepared by J. Ferguson, Bowron Lake Park
79-87	CLI flights
88-89	F and W flights from Region 3 files
90-111	CLI flights
112-119	T. Bergerud flight; Region 5 files
120-144	F and W flights
145	F and W ground survey
146-154	RAB flight
155-156	Region 7 F and W files
157-159	CLI flights

Caribou Sightings:

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93A	Feb 22/78	1	Ridge NW of Goose Peak				2		
93A	Mar 31/78	2	NW of Boss Mt				6		
93A	Jan 25/79	3	Big Slide Mt				1		Smith and Young
93A	Jan 25/79	4	Roaring R				5		Smith and Young
93A	Jan 25/79	5	Brown top Mt				2		Smith and Young
93A	Jan 25/79	6	Plateau above Franks Cr				T		Smith and Young; tracks only
93A	Mar 22/79	7	SW of Bill Miner Cr				3		
93A	Mar 22/79	8	SW of Bill Miner				8		
93A	Mar 22/79	9	Roaring R				8		
93A	Mar 22/79	10	Mt Brew				8		
93A	Mar 22/79	11	Rollie cr				8		
93A	Lt winter	12							
93A	Dec 21/77	13	Archle Cr				T		Any late winter sightings or tracks - Russell and Russell maps
93A	Dec 14/78	14	Tasse L				T		Russell and Russell maps; 1 set tracks
93A	Dec 25/80	15	NE of Meaford L				7+		J. Young (on R&R maps); 2 sets Burt Wartig (OK Heli) 7
93A	Jul 5-10/81	16	Long Cr area				3-4		caribou in burn; more in trees
93A	Jul 5-10/81	17	Long Cr area				1		J. Young; near mineral lick
93A	Jul 5-10/81	18	Lakes S of Long Cr				T		J. Young; in wetland near lick
93A	Jul 5-10/81	19	Pass between Long and Devoe				T		J. Young; many beds and tracks
93A	Jul 5-10/81	20	Welcome Mt				T		J. Young; fresh tracks
93A	Jul 5-10/81	21	Long Cr area						J. Young; caribou sign
93A	Jul 5-10/81	22	Ridge between Long and Devoe						J. Young; trapper has shot caribou here in wetlands
93A	Jul 5-10/81								J. Young; caribou sign along ridge

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93C	Lt Sep/67	23	Hotnarko L				9		Reported to W. Hazeldine by J. Lynn of Courtenay;
93C	Nov/81	24	N of Baezaeko R				several		Authenticity "very possible"
93D	Nov 8/67	25	1/2 mi N of Firvale on Bella Coola hwy				2		Seen by MOF road crew;
93A	Jan 30/62	26	N Arm Quesnel L				12+		reported by M. Demers
93A	Jun 12/61	27	NW of Boss Mt				4		Seen by W. Hazeldine; browsing in 3-4 year old logging slash
93A	Jun 12/61	28	W of Crooked L				6		Clarence Moore, pilot; on lake ice
93A	May 25/61	29	Yanks Peak				48		Clarence Moore, pilot
93A	Aug 10/61	30	E of Niagara Cr				in 2 bands		Clarence Moore, pilot
93A	Mar 11/65	31	Boss Mt				2	1980	Geographical Survey team; bands of 12-28
93A	Apr 10/74	32	Cariboo Mt				T	1520+	H. Mitchell
93A	Apr 10/74	33	Cunningham Cr				3+7		Mitchell and Beets; lots of fresh tracks
93A	Apr 10/74	34	Mt Brew				9+3+1	1770	Mitchell and Beets; lots of skidoo tracks and no caribou on Roundtop
93A	Apr 18/74	35	Big Timothy Mt				T	1830	Mitchell and Beets; tracks all over going from tree to tree
93A	Apr 18/74	36	N slope Eureka Mt				T	1520-1830	Old tracks W of Peak; lots of skidoo tracks on Peak
93A	Apr 18/74	37	Mt Hutch	3	6	2	11	1710	Lots of tracks all over N slope
93A	Apr 18/74	38	Dutchman Mt				T	1770	
93A	Apr 18/74	39	Teapot Cr		2	1	3	1950	
93A	Apr 18/74	40	Big Slide Mt				T	1520-1980	Old tracks
93A	May 1/80	41	N side Mitchell L				T	1650	

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
930	Jul 14-20 /75	45	Plateau S of McKenzie V				21		Parks branch; alpine tundra; in several groups
930	Jul 14-20 /75	46	SE arm Kohasganko cr	1	1	5			Parks Branch; open alpine slopes
930	Jul 14-20 /75	47	Head of N arm Young Cr	1		17			Parks Branch; alpine meadow
930	Jul 14-20 /75	48	Head of E arm Taetaetze Cr			5			Parks Branch; alpine meadow
930	Jul 14-20 /75	49	Plateau SW of Taetaetze Cr	1	1	7			Parks Branch; alpine tundra
930	Mar 23/82	50	Meadow NW of Itcha L			7			Region 6 F&W flight
930	Mar 23/82	51	N side Far Mc			80	1520		Region 6 F&W flight
930	Mar 23/82	52	N side Far Mt			34			Region 6 F&W flight
930	Jul 15/82	53	W end Lanezi L (campsite #34)			5			Bowron Lakes Park Naturalist
930	Early Jun/82	54	Hwy 26-12 mi W of Wells "6"			6			Bowron Lakes Park Naturalist
930	May 30/74	55	W end of ridge N of Cameron Cr and Mitchell R			T	1680		Child and Fujino flight; plentiful tracks
930	Early Fall/77	56	Yanks Peak			T			Quesnel District MOF staff
930	Feb/82	57	Headwaters of Wolf Cr			T			D. Merrick; Quesnel MOF
930	Sep 18/81	58	Palmer Range			8			D. Merrick; Quesnel MOF; by alpine tarn
930	Early Jun/80	59	Cunningham Pass Road			1			D. Merrick; Quesnel MOF;
930	60,61		1600 Rd-W of Bowron Park L						Caribou reported to D. Merrick by loggers
930	Dec or Jan/76	62	W side Cariboo Mt						Quesnel District MOF staff
930	Jan/82	63	Hwy 26 W of Wells					15-6 1300	
930	Dec/80	64	Lightning Cr						Reported by J. Ferguson, Parks Branch
									Reported by J. Ferguson, Parks Branch

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Jan/81	65	Lightning Cr						Reported by J. Ferguson, Parks Branch
93H	Jan/82	66	Lightning Cr						Reported by J. Ferguson, Parks Branch
93H	Dec/80	67	Elk Mt						Reported by J. Ferguson, Parks Branch
93H	Winters 79/80-80/81	68	Richfield Mt						Reported by J. Ferguson, Parks Branch
93H	Dec/80	69	Barkerville Rd						Reported by J. Ferguson, Parks Branch
93H	Apr/81	70	Barkerville Rd						Reported by J. Ferguson, Parks Branch
93H	Mar/80	71	W of Wendle Park						Reported by J. Ferguson, Parks Branch
93H	Jan/81	72	W of Wendle Park						Reported by J. Ferguson, Parks Branch
93H	Sep or Oct 73 79,80 or 81	73	Bowron Lake Park						Reported by J. Ferguson, Parks Branch
93H	/78	74	Pat Point, BLP						Reported by J. Ferguson, Parks Branch
93H	/79	75	Skoil L, BLP						Reported by J. Ferguson, Parks Branch
93H	/80	76	Unna L, BLP						Reported by J. Ferguson, Parks Branch
93H	/81	77	W side Sandy L, BLP						Reported by J. Ferguson, Parks Branch
93H	Sep 30/79	78	S end Isaac L, BLP						Reported by J. Ferguson, Parks Branch
93A	Jan/Feb-69 and 71	79	Headwaters of Penfold Cr						Reported by J. Ferguson, Parks Branch
93A	Jan/Feb-69 and 71	80	Headwaters of Roaring R						Reported by J. Ferguson, Parks Branch
93A	Jan/Feb-69 and 71	81	E end Horsefly L						Reported by J. Ferguson, Parks Branch
									CLI flight; few caribou tracks
									CLI flight; few caribou tracks
									CLI flight

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93A	Jan/Feb- 69 and 71	82	Ridge W of Fritz Cr				6		CLI flight
93A	Jan/Feb- 69 and 71	83	Ridge W of Fritz Cr				T		CLI flight; few caribou tracks
93A	Jan/Feb- 69 and 71	84	Plateau between Moffat Cr and Horsefly R				T		CLI flight; few caribou tracks
93A	Jan/Feb- 69 and 71	85	W of Big Timothy Mt				8		CLI flight
93A	Jan/Feb- 69 and 71	86	Dietrich Cr				T		CLI flight; few caribou tracks
93A	Jan/Feb- 69 and 71	87	S of Mt Hendrix				5		CLI flight
93A	Mar 29-31 /77	88	Bill Miner Cr				18		Region 3 F&W survey flight
93A	Jul 12/65	89	Boss Mt				1	2010	Region 3 F&W survey flight
93C	Jan-Feb/ 67-68	90	Rainbow Range		1		22		CLI flight
93C	Jan-Feb/ 67-68	91	Rainbow Range				150		CLI flight
93C	Jan-Feb/ 67-68	92	Rainbow Range				10		CLI flight
93C	Jan-Feb/ 67-68	93	Rainbow Range				18		CLI flight
93C	Jan-Feb/ 67-68	94	Rainbow Range				15		CLI flight
93C	Jan-Feb/ 67-68	95	Rainbow Range				34		CLI flight
93C	Jan-Feb/ 67-68	96	Rainbow Range				10		CLI flight
93C	Jan-Feb/ 67-68	97	Rainbow Range				6		CLI flight
93C	Jan-Feb/ 67-68	98	Rainbow Range				12		CLI flight
93C	Jan-Feb/ 67-68	99	Rainbow Range				4		CLI flight

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93C	Jan-Feb/ 67-68	100	Far Mt				50		CLI flight
93C	Jan-Feb/ 67-68	101	Far Mt				16		CLI flight
93C	Jan-Feb 67-68	102	Far Mt				40		CLI flight
93C	Jan-Feb 67-68	103	Far Mt				30		CLI flight
93C	Jan-Feb 67-68	104	Far Mt				15		CLI flight
93C	Jan-Feb 67-68	105	Far Mt				20		CLI flight
93C	Jan-Feb 67-68	106	Far Mt				30		CLI flight
93C	Jan-Feb 67-68	107	Far Mt				25		CLI flight
93C	Jan-Feb 67-68	108	Mt Downtown				10		CLI flight
93C	Jan-Feb 67-68	109	Itcha Flats				100		CLI flight
93C	Jan-Feb 67-68	110	S of Itcha Range				T		CLI flight; plentiful tracks
93C	Jan-Feb 67-68	111	Kushya and Coglistiko R				T		CLI flight; few tracks
93C	Oct 31/77	112	Rainbow Range				41		T. Bergerud flight
93C	Oct 31/77	113	Far Mt				16		T. Bergerud flight
93C	Oct 31/77	114	S slopes Ilgachuz Range				T		T. Bergerud flight; any tracks
93C	Oct 31/77	115	S slopes Ilgachuz Range				9		T. Bergerud flight
93C	Oct 31/77	116	S slopes Ilgachuz Range				19		T. Bergerud flight
93C	Oct 31/77	117	W slopes Itcha Range				56		T. Bergerud flight
93C	Oct 31/77	118	W slopes Itcha Range				11		T. Bergerud flight
93C	Oct 31/77	119	W slopes Itcha Range				29		T. Bergerud flight
93C	Jun 1/78	120	Itchas, Ilgachuz and Rainbows		5	5	10		T. Bergerud flight

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93C	Jun 8/79	121	Itchas, Ilgachuz and Rainbows		34	34	68		T. Bergerud flight
93C	Nov 27/79	122	Ridge W of Carnlick Cr				60		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	123	Upper Carnlick Cr				61		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	124	S slope Mt Scot				6		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	125	Headwaters of Pan Cr				19		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	126	S slope Mt Downton				10		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	127	S slope Mt Downton				16		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	128	S slope Mt Downton				6		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	129	NW slope Itcha Range				12		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	130	NW slope Itcha Range				20		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	131	NW slope Itcha Range				6		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	132	NW slope Itcha Range				17		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	133	E slope Mt Downton				3		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	134	E slope Mt Downton				42		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	135	NE slope Itcha Mt				6		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	136	NE slope Itcha Mt				25		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	137	NE slope Itcha Mt				9		F&W flight (from transcript; locations approximate)

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93C	Nov 27/79	138	Itcha L area				8		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	139	Itcha L area				11		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	140	Itcha L area				51		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	141	Itcha L area				6		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	142	Itcha L area				55		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	143	Itcha L area				55		F&W flight (from transcript; locations approximate)
93C	Nov 27/79	144	Mt Downton				5		F&W flight (from transcript; locations approximate)
93C	Jun 9- 15/80	145	Ilgachuz Range			11	11		F&W ground survey; any cow-calf pair
93C	Jul 20-25 /79	146	Ilgachuz Range				1		RAB flight
93C	Jul 20-25 /79	147	Ilgachuz Range				2		RAB flight
93C	Jul 20-25 /79	148	Ilgachuz Range				2		RAB flight
93C	Jul 20-25 /79	149	Ilgachuz Range				2		RAB flight
93C	Jul 20-25 /79	150	Ilgachuz Range				16		RAB flight
93C	Jul 20-25 /79	151	Ilgachuz Range				14		RAB flight
93C	Jul 20-25 /79	152	Ilgachuz Range				37		RAB flight
93C	Jul 20-25 /79	153	Ilgachuz Range				12		RAB flight
93C	Jul 20-25 /79	154	Ilgachuz Range				1		RAB flight

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	May 30/74	155	Ridge NE of McLeary L, Bowron L Park				T		K. Child and K. Fujino; caribou tracks
93H	Jun 16/74	156	Beaverpass area near Eaglenest Mt				2		L. Erickson; in swampy area
93H	Jan-Feb/69	157	N end Isaac L				4		CLI flight
93H	Jan-Feb/69	158	N fork Cariboo R						CLI flight; few tracks
93H	Jan-Feb/69	159	Cariboo R near Sandy L				9		CLI flight

Region 6

Summary of Information Sources:

1-77	Hatter (1979), Table 6. Caribou observations for northern Tweedsmuir Park summer/fall 1978
78-85	Hazelwood (1975)
86-89	Low (1965)
90-93	Miscellaneous
94-99	Miller (1977)
100-101	Hatler, 1978 Proposal for distribution and movements study, northern Tweedsmuir caribou
102-184	Hatter (1979), Table 5
185-187	Ken Child, field notebooks
188-190	CLI flights, Telkwa Range, Jan 5-Feb 8/68
191-194	RAB flights, Telkwa Range, Feb 11-27, March 21/74
195-203	TSB flight, Telkwa Range, Feb 22/82
204-214	Theberge and Gosenbrug (1977)
215-220	Miscellaneous
221-290	Hodson (1977) and flight reports from Hodson study; F and W Branch files
291-296	Miscellaneous; F and W Branch files
297-307	F and W Branch flights
308-340	D. Hatler (pers. comm.)
341	Miscellaneous
342-367	CLI and RAB flights
368-380	R. Marshall

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Jul 14/78	18	Chikamin Mtn, S side			4	18		
93E	Jul 14/78	19	Chikamin Mtn, E side	1			1		
93E	Jul 15/78	20	NW of Chief Ridge				40	1677-1830	Alpine tundra
93E	Mid Jul/78	21	Grell Cove				1	860	
93E	Jul 29/78	22	Arete Mtn, SW Ridge		2	2	4	1555	Snowfield
93E	Jul 30/78	23	Ride S of Mt Stranak	1	5	4	1	1555	Snowfield
93E	Jul 31/78	24	Ridge SW of Lindquist Lk		5	4	9	1737	Snowfield
93E	Jul 31/78	25	Ride SW of Mt Stranak		2	2	4	1737	Snowfield
93E	Jul 31/78	26	Mt. Musclove, N side		1	1	2	1800	Snowfield
93E	Jul/78	27	John Buchan Is	3			3	860	glacier
93E	Jul-Aug/78	28	Chief Louis Lk				50-60	1067	-
93E	Aug 1/78	29	Rail Portage	1			1	860	-
93E	Aug 1/78	30	Mt Musclove	1			1	1890	glacier
93E	Aug 2/78	31	W of Chikamin Pass		1	1	2		snowfield
93E	Aug 2/78	32	Ridge WSW of Arete Mtn		4	4	10	1890	snowfield
93E	Aug 3/78	33	Chikamin Pass, NW end		1		1	1740	alpine meadow/krummholz
93E	Aug 3/78	34	Chikamin Mtn, SW side				3	2073	rock ridge
93E	Aug 6/78	35	Rail Portage				1	860	-
93E	Aug 7/78	36	E side St Thomas Bay		1	1	2	860	-
93E	Aug 9/78	37	Valley NW of Eutsuk Pk	1			1		alpine meadow/krummholz
93E	Aug 16/78	38	Grizzly Lake	1			1	1555	subalpine meadow
93E	Aug 16/78	39	Chikamin Bay				3	853	water
93E	Aug 18/78	40	N of Goosefoot Lk		1		2	1585	meadow
93E	Aug 18/78	41	Grizzly Lake	3			3	1570	subalpine meadow
93E	Aug 19/78	42	Grizzly Lake			1	1	1646	subalpine meadow
93E	Aug 21/78	43	Blanchet Lk				2	1372	swimming
93E	Aug 21/78	44	S of Blanchet Lk		1	2	3	1387	sedge meadow
93E	Aug 28/78	45	St Thomas Bay		1		1	860	
93E	Sep 9/78	46	Sabina Lk	1			1	1097	-
93E	Sep 17/78	47	5 mi N of Sabina Lk				1	1097	-
93E	Sep 19/78	48	5 mi N of Sabina Lk	1			5	1097	-
93E	Sep 20/78	49	6 mi N of Sabina Lk				6	1067	-

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Sep 23/78	50	Thetelban Lk	2	2	1	5	1036	-
93E	Sep 23/78	51	1 mi E of Thetelban	2			8	1067	-
93E	Sep 24/78	52	1.5 mi W of Thetelban Lk	3	3	3	20	1067	-
93E	Sep 30/78	53	Sabina Lk				3	1097	-
93E	Oct 1/78	54	Sabina Lk				3	1097	-
93E	Oct 1/78	55	Thetelban Lk				5	1036	-
93E	Oct 2/78	56	1 mi S of Thetelban Lk		1		5	1067	-
93E	Oct 4/78	57	2 m' S Sabina Lk	1	1		2	1036	-
93E	Oct 1-6/78	58	3 mi N of Sabina Lk				7	1220	meadow
93E	Oct 1-6/78	59	N of Sabina Lk				7	1067	meadow
93E	Oct 1-6/78	60	4 mi NNW of Uduk Lk	1			9	1067	meadow
93E	Oct 1-6/78	61	2 mi SSE of Thetelban Lk				20	1067	-
93E	Oct 1-6/78	62	E of Nutli Lk				7	1220	meadow
93E	Oct 1-6/78	63	Tweedsmuir Pk, S side	2			10	1830	snowpatch
93E	Oct 6/78	64	Tweedsmuir Pk, S side				2	1830	snowpatch
93E	Oct 6/78	65	Wells Gray Pk, E Plateau	1			10-12	1677	alpine tundra
93E	Oct 6/78	66	NW of Grizzly Lk	1			2	1615	subalpine meadow
93E	Oct 6/78	67	SE of Goodrich Lk	1			2	1372	meadow
93E	Oct 6/78	68	S of Sabina Lake				1		meadow
93E	Oct 7/78	69	Grizzly Lake, S side	3		5	19	1555	subalpine meadow
93E	Oct 8/78	70	Wells Gray Pk, W Plateau	4		7	45	1768	alpine tundra
93E	Oct 9/78	71	W of Grizzly Lk	1			1	1600	subalpine meadow
93E	Oct 12/78	72	Wells Gray Pk, W	11		14	74	1768	alpine tundra
93E	Oct 12/78	73	Michel Pk, E				15	1740	alpine tundra
93E	Oct 26/78	74	Tweedsmuir Pk, SE side	2	10	7	28	1798	alpine tundra
93E	Oct 26/78	75	Michel Pk, E Plateau	2	7	5	24	1707	alpine tundra
93E	Oct 26/78	76	NE of Blanchet Lk	2	3	3	14	1585	meadow
93E	Oct 26/78	77	Eutsuk Pk, NE side	2	4	2	11	1585	subalpine meadow
93E	Aug 4-11/75	78	NW of Tweedsmuir Pk		1		2		Hazelwood (1975 A:9); wet meadow/scrub fir habitat
93E	Aug 4-11/75	79	N of Tweedsmuir Pk				3		Hazelwood (1975 A:9); alpine tundra
93E	Aug 4-11/75	80	E of Tweedsmuir Pk				2		Hazelwood (1975 A:11); reported by A. Blackwell
93E	Mar /75	81	Ridges E of Tweedsmuir Pk				100		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Aug 6-15/75	82	E of Michel Pk				3		Hazelwood (1975 A:26); snow patch/steep meadow habitat
93E	Jul 20-30/75	83	S of Surel L	4			4		Hazelwood (1975 B:11); on snow slope
93E	Jul 20-30/75	84	Pass between Arete Mt & Chikamin Mt	2	28	28	80	in several groups	Hazelwood (1975 B:11); meadow, tundra, and timber
93E	Jul 20-30/75	85	NW end Chikamin Range		3	2	10		Hazelwood (1975 B:11); scrub fir/meadow
93E	Jan-Feb/64	86	W end Chief Louis Lake				T		Low (1965); in meadows
93E	Jan-Feb/64	87	N of Glattheli Lake				T	4000	Low (1965); in forest
93E	Jan-Feb/64	88	Mt Wells & Tweedsmuir Pk				147	6500	Low (1965); above timberline
93E	Mid-Apr/64	89	Mt Wells				129		Low (1965); reported by B. Harrison
93E	Oct 9/79	90	Michel Pk	1		1	4		G. Hazelwood, Parks Br. flight
93E	Oct 9/79	91	S slope Wells Gray Pk		1		1		G. Hazelwood, Parks Br. flight
93E	Jun 2/77	92	Chikamin Range				5		D. Hatler
93E		93	S of mid-Fenton Lake	1			1		D. Hatler
93E	Aug 11/77	94	N slope Tweedsmuir Pk	1			1		Miller (1977); on snowpack
93E	Aug 13/77	95	E slope Tweedsmuir Pk	1			1		Miller (1977); at treeline
93E	Aug 16/77	96	Fenton Lake cabin	1			1		Miller (1977); in meadow
93E	Aug 17/77	97	Chikamin-Arete Pass	1			4		Muller (1977)
93E	Aug 18/77	98	NW slope Chikamin Mt.		3	3	6		Miller (1977)
93E	Summer /77	99	Chikamin Range (mostly in in Chikamin-Arete pass)		3		65		Miller (1977); reported by A. Blackwell
93E	Early April/65	100	Mt Wells				175		B. Richmond (former C.O.)
93E	Summer/63	101	near Fenton Lake				321		B. Richmond (former C.O.)
93E	Sept/55	102	Wells Gray Pk, E side				300		Hatter (1979), Table 5
93E	Aug 7-15/59	103	Michel Pk		13		41		Hatter (1979), Table 5
93E	Aug 7-15/59	104	Wells Gray Pk		2		7		Hatter (1979), Table 5
93E					4		13		
93E					4		14		
93E					5		22		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Oct 14-15/59	105	Tweedsmuir Pk, E side				48		Hatter (1979), Table 5
93E	Oct 14-15/59	106	between Michel Pk and Goodrich Lk				3		Hatter (1979), Table 5
93E	Oct 14-15/59	107	Fenton Lk, NW end				38		Hatter (1979), Table 5
93E	Oct 14-15/59	108	Blanchet Lk, N shore				15		Hatter (1979), Table 5
93E	Oct 14-15/59	109	Wells Gray Pk, E slope				20-30		Hatter (1979), Table 5
93E	Jul/63	110	Chef Ridge, W plateau				320		Hatter (1979), Table 5
93E	Jul/63	111	Tweedsmuir Pk				106		Hatter (1979), Table 5
93E	Sep 28/63	112	W of Fenton Lk				300		Hatter (1979), Table 5
93E	Oct 7-11/63	113	Chef Ridge				17		Hatter (1979), Table 5
93E	Oct 22/63	114	Ermine Pk	2	16		18		Hatter (1979), Table 5
93E	Oct 25-Nov 3/63	115	Blanchet Lk				8		Hatter (1979), Table 5
93E	Oct 25-Nov 3/63	116	Fenton-Goodrich Lks area				1		Hatter (1979), Table 5
93E	Aug 25-Sep 3/64	117	Ermine Pk area	1			1		Hatter (1979), Table 5
93E	Aug 25-Sep 3/64	118	Wells Gray Slope				1		Hatter (1979), Table 5
93E	Sep 8-23/65	119	Fenton Lk area	1			1		Hatter (1979), Table 5
93E	Oct 15/65	120	Fenton Lk	1			1		Hatter (1979), Table 5
93E	Jun 25/67	121	Fenton Lk area, alpine				300		Hatter (1979), Table 5
93E	Winter /67-8	122	Glatheili Lk				36		Hatter (1979), Table 5
93F	Feb/68	124	Cheslatta Lk				4		Hatter (1979), Table 5
93E	Sep 4-14/68	125	Fenton Lk	1	2	1	1		Hatter (1979), Table 5

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Aug 16-22/69	126	Fenton Lk area		6		6		Hatter (1979), Table 5
93E	Sep 5-9/70	127	Fenton Lk area				30		Hatter (1979), Table 5
93E	Sep 10-15/70	128	Rail Portage				150		Hatter (1979), Table 5
93E	Oct 17/71	129	Homestead Meadows	1			1		Hatter (1979), Table 5
93E	Oct 23/71	130	Michel Pk	2	3		18		Hatter (1979), Table 5
93F	Winter/72	131	N of Whiteye Lk	1	1		60		Hatter (1979), Table 5
				1			2		
93E	Oct 16-31/72	132	Fenton Lk area;	1			1		Hatter (1979), Table 5
			Homestead Meadows	1			2		
				25			25		
				3			3		
93E	Oct 16-31/72	133	Gull Ridge	1			1		Hatter (1979), Table 5
93E	Oct 16-31/72	134	Goodrich Lk				2		Hatter (1979), Table 5
93F	Winter /74	135	Swamp system N of Intata Reach						Hatter (1979), Table 5
93F	Feb 7-9/74	136	Cheslatta Lk				25		Hatter (1979), Table 5
93F	Mar/74	137	Ootsance Lk				4		Hatter (1979), Table 5
93E	Feb/75	138	Henson Hills				8		Hatter (1979), Table 5
93F	Feb/75	139	Jim Smith Pt				15		Hatter (1979), Table 5
93E	Aug 4-11/75	140	NW of Sural Pk		1		1		Hatter (1979), Table 5
							1		
			N of Tweedsmuir Pk				5		
			E of Tweedsmuir Pk				2		
			E of Michel Pk				3		
			Pinkut Lk				1		Hatter (1979), Table 5
93E	Aug 26/75	141	Fenton Lk area				2		Hatter (1979), Table 5
93E	Sep 20-29/75	142					1		
				1			1		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Jan 5/76	143	Chief Louis Lk				6		Hatter (1979), Table 5
93E	Jan 15/76	144	Lot 1637, Francois Lk				2		Hatter (1979), Table 5
93E	Feb/76	145	Tweedsmuir Pk				3		Hatter (1979), Table 5
93F	Mar/76	146	Jim Smith Pt				1		Hatter (1979), Table 5
93E	Jul 1/76	147	St Thomas Narrows				1		Hatter (1979), Table 5
93E	Jul 1-	148	St Thomas Narrows				2		Hatter (1979), Table 5
	16/76		Fenton Lk area	3	23	1	27		Hatter (1979), Table 5
93E	Jul 11/76	149A	Wells Gray Pk, N. face				6		
93E	Aug 10/76	149B	Tweedsmuir Pk, E slope				2		Hatter (1979), Table 5
93E	Sep 22/76	150	Ptarmigan Pk				5		Hatter (1979), Table 5
93E	Sep 22/76	151	Arête Mt		1	2	11		Hatter (1979), Table 5
93E	Sep 25-	152	Homestead Meadows;				3		Hatter (1979), Table 5
	30/76		Fenton Cabin	1			29		Hatter (1979), Table 5
				2			1		
				1	7		2		
93E	Winter	153	Mt Wells				8		Hatter (1979), Table 5
	76-77						7		
93E	Mar 17/77	154A	Ootsa Lake				4		Hatter (1979), Table 5
93E	Mar /77	154B	Spud Lake				1		Hatter (1979), Table 5
93E	Apr 20/77	155	Tweedsmuir Pk, E side				3		Hatter (1979), Table 5
93F	Apr 23	156	Marilla				3		Hatter (1979), Table 5
	-24/77								
93E	Apr 25/77	157	Wisteria Landing				3		Hatter (1979), Table 5
93E	Apr 25/77	158	Andrew Bay				5		Hatter (1979), Table 5
93E	Jul 4/77	159	Pondosy Lake	1			5		Hatter (1979), Table 5
93E	Aug 4/77	160	Kimsquit Cr	1			6		Hatter (1979), Table 5
93E	Aug 12/77	161	Tochquonyalla Range			2	9		Hatter (1979), Table 5
93E	Aug 22/77	162	Rail Portage				1		Hatter (1979), Table 5

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Fall /77	163	Whitesail Reach, opposite Andrew Bay				200		Hatter (1979), Table 5
93E	Oct 15/77	164	saddle above Zinc Bay	1	3	2	6		Hatter (1979), Table 5
93E	Oct 15/77	165	slope overlooking Rail Portage	2	6		14		Hatter (1979), Table 5
93E	Oct 15/77	166	Chief Louis Lake				6-8		Hatter (1979), Table 5
93E	Winter 77/8	167	Chief Louis Lake				63		Hatter (1979), Table 5
93F	Winter 77/8	168	Intata Reach, N side				36-45		Hatter (1979), Table 5
93F	Winter 77/8	169	Bird Lake				2		Hatter (1979), Table 5
93F	Feb/78	170	Ootsance Lake, SW				4		Hatter (1979), Table 5
93F	Feb/78	171	Murray Lake, SE				12		Hatter (1979), Table 5
93F	Feb/78	172	W of Nechako Canyon				12		Hatter (1979), Table 5
93F	Feb/78	173	Mt Swannel				63		Hatter (1979), Table 5
93E	Feb/78	174	Chief Louis Lake				30		Hatter (1979), Table 5
93F	Feb 15/78	175	Capoose Lake				40		Hatter (1979), Table 5
93F	Feb 24/78	176	Mt Tutiai				60		Hatter (1979), Table 5
93F	Feb 24/78	177	Fawnie Nose				8		Hatter (1979), Table 5
93F	Feb 24/78	178	Capoose Lake				7		Hatter (1979), Table 5
93E	Feb 24/78	179	Mt Wells, N aspect				16		Hatter (1979), Table 5
93E	Feb 24/78	180	Tweedsmuir Pk				7		Hatter (1979), Table 5
93F	Mar 5/78	181	Capoose Lake				12		Hatter (1979), Table 5
93F	Mar 7/78	182	Fawnie Nose				30		Hatter (1979), Table 5
93F	Mar 7/78	183	Capoose Cr, headwaters				12		Hatter (1979), Table 5
93E	Apr 14/78	184	Mt Wells - Tweedsmuir Pk				30	1680-1830	Hatter (1979), Table 5
93E	Oct 31/74	185	Windy Point						R. Hilde (from K. Child)
93F	Feb 17/78	186	Capoose L				47		Dan Wiebe
93F	Nov 7/73	187	Lot 1954, E Ootsa L						P. and B. Carroll; first saw caribou here in summer/73
93L	Jan 5- Feb 8/68	188	Glacis Cr				2		CLI flight

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93L	Jan 5- Feb 8/68	189	Cabinet Cr				7		CLI flight
93L	Jan 5- Feb 8/68	190	Webster Cr				1		CLI flight
93L	Feb 11-27	191	W of Eagle Peak				T		WAB flight; few tracks
93L	Mar 21/74	192	Sunsets Cr				6		RAB flight
93L	Feb 11-27	193	Sunsets Cr				1		RAB flight
93L	Mar 21/74	194	HW Dockrill Cr				2		RAB flight
93L	Feb 22/82	195	N of Dockrill Cr				11		TSB flight; windswept alpine
93L	Feb 22/82	196	E of Webster Cr				6		TSB flight; windswept alpine
93L	Feb 22/82	197	W of Webster Cr				6		TSB flight
93L	Feb 22/82	198	W of Webster Cr				3		TSB flight; windswept alpine
93L	Feb 22/82	199	N of Glacis Cr				13		TSB flight
93L	Feb 22/82	200	Houston Tommy drainage				5		TSB flight; windswept alpine
93L	Feb 22/82	201	Houston Tommy drainage				11		TSB flight; windswept alpine
93L	Feb 22/82	202	Houston Tommy drainage				5		TSB flight; windswept alpine
93L	Feb 22/82	203	Between Emerson and Dockrill Cr				11		TSB flight; windswept alpine
93L	Aug 5/76	204	Between Denys and Sunsets Crs	1	6	1	11	1891	Theberge and Oosenbrug (1977); on or near snow
93L	Aug 5/76	205	W of Houston Tommy	1	4	1	6	1769	Theberge and Oosenbrug (1977); feeding in alpine
93L	Aug 6/76	206	Between Emerson and Houston Tommy	2	6	1	11	1739	Theberge and Oosenbrug (1977); feeding in alpine
93L	Aug 7/76	207	Upper Houston Tommy Cr	3	6	1	12	1708	Theberge and Oosenbrug (1977); feeding in alpine
93L	Aug 7/76	208	Upper Denys Cr		1	1	2	1632	Theberge and Oosenbrug (1977); feeding in alpine
93L	Aug 7/76	209	W of Houston Tommy	1	1	1	4	1739	Theberge and Oosenbrug (1977)

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93L	Aug 8/76	210	Upper Houston Tommy		3	2	6	1800	Theberge and Oosenbrug (1977); lying on snow
93L	Aug 8/76	211	Upper Houston Tommy		1	1	2	1678	Theberge and Oosenbrug (1977); feeding in alpine
93L	Aug 16/76	212	Between Goathorn and Dockrill Crs				2	1639	Theberge and Oosenbrug (1977)
93L	Sep 3/76	213	Between Goathorn and Dockrill Crs	1	2		3	1647	Theberge and Oosenbrug (1977)
93L	Sep 8/76	214	Ridge E of S Burnie L	1	3		4	1524	Theberge and Oosenbrug (1977); feeding on alpine
93L	Jun 3/80	215	Herd Dome	2	3		5		G. Hazelwood
93L	Jun 19/80	216	Herd Dome		3	1	4		G. Hazelwood
93L	Aug 23-30	217	E of Burnie L				1		Osmond-Jones et al. (1975); alpine
93L	Aug 23-30	218	E of Burnie L				2		Osmond-Jones et al. (1975); alpine
93L	Sep-Oct/66	219	E of Burnie L				8		G. Hazelwood
93L	Nov 17/75	220	Between Goathorn and Dockrill Cr			2	38		Dawn Remington (F&W Branch files)
93L	"Early Spring"	221	Mooseskin Johnny L				3-4		E. Mesich, in Hodson (1977); swimming in lake
93L	Oct/77	222	Upper Thautil Cr				7-8		E. Mesich, in Hodson (1977)
93L	Jan 21/77	223	W side Camel Humps				21		K. Hodson; open, partly blown slopes
93L		224	Dockrill Plateau				2		K. Hodson; digging in deep snow
93L		225	Ridge E of Hankin Basin				4		K. Hodson; on top on blown slopes
93L		226	Evening-Scallon Plateau				7		K. Hodson; little windblown area
93L	Jan 31/77	227	Camel Humps				11		K. Hodson
93L		228	Hankin-Dockrill Plateau	1		1	4		K. Hodson
93L		229	Dockrill Plateau				2		K. Hodson
93L		230	Evening-Scallon Plateau			3	7		K. Hodson
93L	Feb 8/77	231	Camel Humps	2	6	3	11		K. Hodson

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93L	Feb 15/77	232	Evening-Scallion Plateau				7		K. Hodson
93L		233	Camel Humps				14		K. Hodson; rocky, almost bare slopes
93L	Mar 8/77	234	Hankin-Dockrill Plateau				6		K. Hodson
93L		235	Evening-Scallion Plateau				9		K. Hodson
93L		236	Camel Humps				12		K. Hodson
93L		237	Hankin-Dockrill Plateau				6		K. Hodson
93L	Mar 13/77	238	Camel Humps	3	5	2	10		D. Bustard; feeding on alpine
93L	Mar 14/77	239	Camel Humps				16		K. Hodson
93L	Mar 16/77	240	Evening-Scallion Plateau	3	4	2	11		K. Hodson
93L	Mar 17/77	241	Hankin-Dockrill Plateau				6		K. Hodson
93L	Mar 21/77	242	Hankin-Dockrill Plateau				4		K. Hodson
93L	Mar 21/77	243	Camel Humps				2		K. Hodson; caribou app using subalpine areas
93L	Mar 29/77	244	Hankin-Dockrill Plateau				6		K. Hodson; in subalpine timber
93L	Mar 29/77	245	Dockrill-Emerson Plateau				2		K. Hodson
93L	Mar 29/77	246	Evening-Scallion Plateau				9		K. Hodson
93L	Apr 4/77	246	Hankin-Dockrill Plateau				5		K. Hodson; many bare spots
93L	Apr 4/77	247	Cabinet-Webster Plateau				8		K. Hodson
93L	Apr 4/77	248	Camel Humps				3		K. Hodson
93L	Apr 9/77	249	Hill between Glacis L and Hunters Basin	1	3		4		K. Hodson
93L	Apr 20/77	250	Hankin-Dockrill Plateau				6		K. Hodson
93L	Apr 20/77	251	Cabinet-Webster Plateau				8		K. Hodson
93L	Apr 20/77	252	E Elliot Plateau				5		K. Hodson; much pawing on ridge; ridge edge free of snow
93L	May 4/77	253	Hankin-Dockrill Plateau				5		K. Hodson
93L	May 4/77	254	Evening-Scallion Plateau				10		K. Hodson
93L	May 11/77	255	Dockrill L Plateau				6		K. Hodson
93L	May 18/77	256	Dockrill L Plateau				18		K. Hodson
93L	Jun 2/77	257	Dockrill L Plateau				15		K. Hodson; no calves yet
93L	Jun 14/77	258	Dockrill L Plateau				1		K. Hodson; at treeline
93L	Jun 14/77	259	Dockrill Plateau S of ice	1	1		5		K. Hodson; 3 bedded in snow

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93L	Jun 27/77	260	Ridge SE of icefield N of S arm of Dockerill Cr		1	1	2		K. Hodson
93L	June 27/77	261	S side Emerson cr		1	1	2		K. Hodson
93L	Jun 27/77	262	Lower Dockerill Plateau				4		K. Hodson
93E	Early Sep/76	263	Tableland Mt				3-4		Chuck Whitney, Houston
	Sep/76								
	264		Mt Morice				2		John Shepherd
	Aug/70	265	Shore of Grizzly L				4		C. Effa, MOF
93L	Jul 4/77	266	S side Glacis Cr			1	5		E. Mesich
93L	Jul 13/77	267	Dockerill Plateau				6		K. Hodson
93L	Jul 13/77	268	HW Emerson Cr			5	17		K. Hodson
93L	Jul 25/77	269	Houston Tommy Cr mining camp			3	14		K. Hodson
93L	Aug 5/77	270	Houston Tommy Cr mining camp			3	11		K. Hodson
93L	Aug 18/77	271	Houston Tommy Cr mining camp						K. Hodson; collared caribou in timber
93L	Aug 14/77	272	Between HW Denys and Houston Tommy camp				4		D. Hatler
93L	Oct 3/77	273	SE of Houston Tommy camp	1	8	3	15		K. Hodson
93L	Sep 30/77	274	In 2130	1	2		15		K. Hodson
93L	Nov 4/77	275	Evening-Scallon Plateau	1			3		K. Hodson
93L	Nov 4/77	276	Denys Cr				23		K. Hodson
93L	Nov 4/77	277	Houston Tommy Mining camp				6		K. Hodson
93L	Nov 18/77	278	Evening-Scallon Plateau	1	1	1	3		K. Hodson
93L	Nov 18/77	279	Hankin-Dockerill Plateau				24		K. Hodson
93L	Nov 18/77	280	Houston Tommy Mining camp	1	3	2	7		K. Hodson
93L	Dec 19/77	281	Hankin-Dockerill Plateau		14	5	19		K. Hodson
93L	Dec 19/77	282	Houston Tommy Mining camp	1	3	2	6		K. Hodson
93L	Dec 19/77	283	W side Camel Humps	2	8	2	12		K. Hodson
93L	Dec 19/77	284	Sunsets Cr Plateau, Howson Range	1	1	1	3		K. Hodson
93L	Dec 19/77	285	Camel Humps						K. Hodson
93L	Dec 19/77	286	Hankin-Dockerill Plateau				9		K. Hodson

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93L	Jan 5/79	287	NW of Camel Humps		2	2	4		K. Hodson
93L	Jan 5/79	288	Evening-Scallion Plateau	1	6	3	10		K. Hodson
93L	Jan 5/79	289	Houston Tommy Mining Camp		6	1	7		K. Hodson
93L	Jan 5/79	290	Houston Tommy Mining camp	5	11	7	33		K. Hodson; along snowmobile route from treeline to mining camp
93L	Aug 12/81	291	HW Denys Cr				3		T. Parkin (Parks Br); upper extent of timber
93L	Feb 11/76	292	Dockrill Cr area				3		G. Hazelwood; at treeline
93L	Feb 11/76	293	Hunters Basin				6		G. Hazelwood; snowmobile tracks present
93L	Feb 11/76	294	HW Denys Cr		1	1	2		G. Hazelwood
93E	Mar 25/75	295	Lot 4534, Francois L				1		R. Slavens, Burns Lake CO; "According to some locals it has been more than 60 yrs since caribou were seen on N side Francois L"
93E	Winter/75	296	S of Noralee				25		R. Slavens; observed by Noralee residents
93E	Mar 20/82	297	Mt. Swannell				10	1520+	R. Marshall; F&W survey flight
93E	Mar 20/82	298	Capoose L				10	1010	R. Marshall; F&W survey flight
93E	Mar 20/82	299	Capoose L				14	910	R. Marshall; F&W survey flight
93E	Mar 20/82	300	Tutial Mt				151	1520	R. Marshall; in several groups
93E	Mar 20/82	301	Fawnie Nose				183	1520	R. Marshall; in several groups
93E	Mar 23/82	302	Mt Swannell				2		R. Marshall; in several groups
93E	Mar 23/82	303	Capoose L				4		R. Marshall; some cratering
93E	Mar 23/82	304	Tutial Mt ridge tops				210		R. Marshall; digging for slush
93E	Mar 23/82	305	Fawnie Nose				97		R. Marshall; in several groups
93L	Feb 24/78	306	Camel Humps				12		R. Marshall; in several groups
93L	Feb 24/78	307	Hankin-Dockrill Plateau				18		F&W survey flight
93L	Dec 28/82	308	Canyon Cr				13		F&W survey flight
93E	Mar 16/65	309	Mt Wells			25	162		Neil Trenholme; definite tracks and pellets of about 3 caribou

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Apr 12/65	310	Mt Wells			8	175		
93E	Summer/76	311	Near Sibola Peak				?		B. Olson, Forest Service
93E	Summer/76?	312	Headwaters Bergeland Cr				3?		Reported to D. Hatler by hikers
93F	May 2/79	313	Marilla Main and M-5				7		Eurocan employees
93F	May 11/79	314	Block 9 CP079-below road				4		Eurocan employees
93F	May 14/79	315	Block 9 CP079-above road				4		Eurocan employees
93F	May 16/79	316	Block 6 CP079				2		Eurocan employees
93F	May 21/79	317	Block 6 CP079 on M-12				3		Eurocan employees
93F	Oct 31/79	318	Block 10 CP145				9		Eurocan employees
93F	Apr 21-	319	Marilla Main area				6		Eurocan employees
93E	May 11/80								
93E	Jan 16/80	320	Andrews Bay			1	3		
93F	Jan 19/80	321	NE of E Ootsa camp				4		
93E	Fall/76?	322	Logging road near Sandifer L				?		Loggers from Kemano
93E	Sep 16/79	323	Thletelban L				2		Alan Blackwell, guide
93E	Sep 19/79	324	S of Thletelban L				4		Alan Blackwell
93E	Sep 21/79	325	S of Thletelban L	1	1	1	3		Alan Blackwell
93E	Sep 21/79	326	Sabina L				2		Alan Blackwell
93E	Sep 24/79	327	Tweedsmuir Peak		1	1	2		Alan Blackwell
93E	Sep 25/79	328	N of Thletelban L				6		Alan Blackwell
93E	Sep 26/79	329	S of Thletelban L				1		Alan Blackwell
93E	Sep 27/79	330	Sabina L	1			1		Alan Blackwell
93E	Sep 30/79	331	Thletelban L				1		Alan Blackwell
93E	Oct 2/79	332	Sabina L				12		Alan Blackwell
93E	Oct 3/79	333	Sabina L				7		Alan Blackwell
93E	Oct 5/79	334	Chief Louis L				5		Alan Blackwell
93E	Oct 6/79	335	Sabina L				3		Alan Blackwell
93E	Oct 7/79	336	Thleteban L				8		Alan Blackwell
93E	Oct 8/79	337	N of Sabina L				4		Alan Blackwell
93E	Oct 9/79	338	Thletelban L				5		Alan Blackwell
93E	Oct 9/79	339	Between Sabina and Ootsa L				7		Alan Blackwell
93E	Oct 13/79	340	Whitetail Range	5			5		Alan Blackwell

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93F	Mid-March /83	341	Between Fawnie Nose and Mt Swannell on S slopes				400+		John Braithwaite; caribou were "down in trees"; reported by R. Marshall
93E	Jan 5- Feb 8/68	342	Sibola Peak				9		CLI flight
93E	Jan 5- Feb 8/68	343	Sibola Peak				1		CLI flight
93E	Jan 5- Feb 8/68	344	Sibola Peak				4		CLI flight
93E	Jan 5- Feb 8/68	345	Sibola Peak				5		CLI flight
93E	Jan 5- Feb 8/68	346	Sibola Peak				T		CLI flight; moderate trails
93E	Jan 5- Feb 8/68	347	Sibola Peak				18		CLI flight
93E	Jan 5- Feb 8/68	348	Sibola Peak				3		CLI flight
93E	Jan 5- Feb 8/68	349	Sibola Peak				8		CLI flight
93E	Jan 5- Feb 8/68	350	Sibola Peak				1		CLI flight
93E	Jan 5- Feb 8/68	351	Sibola Peak				9		CLI flight
93E	Jan 5- Feb 8/68	352	Tweedsmuir Peak				T		CLI flight; few tracks
93E	Jan 5- Feb 8/68	353	W end of Glattheli L				4		CLI flight
93E	Jan 5- Feb 8/68	354	S side Michel Pk				7		CLI flight
93E	Jan 5- Feb 8/68	355	S side Michel Pk				6		CLI flight
93E	Jan 5- Feb 8/68	356	S side Michel Pk				13		CLI flight
93E	Jan 5- Feb 8/68	357	S side Michel Pk				6		CLI flight

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93E	Feb 11-26 Mar 19-21 /74	358	Mt Wells				2		RAB flight
93E		359	Tweedsmuir Peak				11		RAB flight
93E		360	NE of Michel Peak				T		RAB flight; few tracks
93E		361	NE of Sabina L				T		RAB flight; few tracks
93E		362	N end Uduk L				T		RAB flight; few tracks
93F	Jan-Feb/66	363	E of Enz L				12		CLI flight
93F	Jan-Feb/66	364	S of Cheslatta I				4		CLI flight
93F	Jan 25/68	365	Cheslatta L				4		CLI flight
93F	Jan 25/68	366	N shore Natakuz L, opposite Jim Smith Pt				1		CLI flight
93F	Feb 7-9/74	367	Cheslatta-Bird L area				T		RAB flight; any caribou tracks
93E	Sep 25/84	368	Chikamin Range				21		R. Marshall
93E	Aug 2/84	369	Mt Wells				34		R. Marshall
93E	Jul 25/84	370	Mt Wells				45		R. Marshall
93E	Aug 2/84	371	Tweedsmuir Peak				5		R. Marshall
93E	Aug 2/84	372	SE slope Michel Pk				12		R. Marshall
93E	Aug 2/84	373	W of Goodrich L				4		R. Marshall
93E	Jul 25/84	374	Wells Gray Pk				38		R. Marshall
93F	Apr 4/84	375	N of Tetachuk L				10		R. Marshall
93F	Feb 1/84	376	Entiako L				2		R. Marshall
93F	Feb 1/84	377	Entiako L				14		R. Marshall
93F	Feb 1/84	378	Naglico Hills				4		R. Marshall
93F	Feb 1/84	379	Naglico Hills				11		R. Marshall
93E	Jun 7/84	380	Naglico Hills						R. Marshall; apparent calving sites

Region 7 (Omineca subregion)

Summary of Information Sources:

1-117	Bloomfield (1979, App. D.) Details provided by R. Weinard
118-138	Reported by R. Weinard
139-178	S. Stevenson - personal files
179-240	Ken Child's field books
241-250	George Evanoff
251-280	RAB flight maps and transects; NE coal study
281-295	Fish and Wildlife Branch caribou files
296-312	Renewable Resources observations, with additions from Ken Child
313-320	Misc.
321-325	Reported by R. Weinard
326-328	Misc.
329-338	Reported to G. Hazelwood by M. Vatamaniuk
339-348	TSB flight March 11/82
349-355	Misc., mostly G. Hazelwood
356-362	Ken Child's field books
363-368	Tim Cushman, guide-outfitter at Bowron Lake
369-370	Misc.
371-392	D. King
393	Misc.
394-399	Greg Mutch, reported by D. Stevenson
400-411	J. Edmonds, Alberta F and W, Edson
412-413	B. Wynes, Alberta F and W, Grande Prairie
414-419	NE Coal Study Caribou Sightings (Fort St. John office)
420-425	Misc.
426-428	CLI flights
429-435	Bloomfield (1979, App. F)
436-455	CLI flights
456	Ken Child's field books
457-466	T. Cushman
467-468	B. Little
469-471	Region 5 F and W flight
472-477	Fish and Wildlife Branch caribou files

Caribou Sightings:

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Jan 10/75	1	Hwy 16, 15 mile W of McBride	1	2		3	890	M. Vatamaniuk; cedar-hemlock-spruce forest
93H	Jan 26/75	2	W. Twin Cr & Hwy 16				15	830	Cedar-hemlock-spruce forest
93H	Feb 8/75	3	Raven Lake				16	1660	B. Norheim; on ice
93H	Feb 13/75	4	POB Creek				7	762	D. Nyghard; cedar-hemlock spruce forest
93H	Feb 18/75	5	Raven Lake				14	1660	L. Johnson; on ice
93H	Feb 20/75	6	Hungary Cr at Hwy 16	2			2	760	D. Nyghard; crossing highway to south
93H	Feb 22/75	7	Raven Lake	3	19		22	1660	B. Norheim; at treeline
93H	Mar 6/75	8	Hungary Cr at Hwy 16	1			1	760	R. Weinard
93H	Mar 8/75	9	Raven L	1	12		13	1660	B. Norheim; on ice
93H	Mar 27/75	10	Raven L		4	1	5	1660	B. Norheim
93H	Apr 11/75	11	Grizzly Den				19	1500	K. Child & R. Weinard
93H	May 28/75	12	Slim Creek mineral lick		1		1	762	K. Fujino, K. Child, R. Weinard
93J	Jun 2/75	13	Mt Averil				1	1300	In balsam-spruce forest
							3-5		
93H	Jun 6/75	14	Slim Creek mineral lick		5		5	760	K. Fujino & R. Weinard
93H	Aug 18/75	15	Headwaters of Dove Cr				1	1430	
93H	Sep 30/75	16	Below Grizzly Den	2			2	1490	K. Child & R. Weinard; in balsam-spruce forest
93I	Oct /75	17	Huble Road				5	732	K. Barlaug; 5 single caribou
93I	Oct 1/75	18	Forgetmenot Cr				1	1430	A. Phillips
93H	Oct 30/75	19	Tumuch Rd - Mi 25	1	1	1	3	975	R. Weinard; crossed road heading toward lick
93I	Nov 15/75	20	Church Rd (CP 3)				6	732	K. Barlaug
93H	Nov 19/75	21	Tumuch Rd - Mi 19.3	1			1	884	R. Weinard; carcass found in clearcut
93H	Nov 24/75	22	Below Raven L cabin				T ₂	1615	K. Child, K. Fujino, R. Weinard
93H	Dec 12/75	23	La Salle Lakes				8	805	Feeding on arboreal lichens in cedar-hemlock-spruce forest
93H	Jan 18/76	24	NW end of Raven L				T ₃	1670	K. Child & R. Weinard
93H	Jan 30/76	25	Sugarbowl Mt-Raven L				T	1524+	K. Child & R. Weinard; in alpine
93H	Feb 2/76	26	Grizzly Den - Raven L				6-8		
							3-5	1524+	In alpine

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Feb 5/76	27	Grizzly Den				T	1690	In timberline forest
93H	Mar 12/76	28	Driscoll Cr		3		3-5		
93H	Mar 19/76	29	Hungary Cr just S of Hwy 16		4		3	1590	In balsam-spruce forest
93H	Mar 24/76	30	Hwy 16, 6 mi E of Purden L	1	5		4	755	In cedar-hemlock-spruce forest
93H	Apr 3/76	31	Driscoll Cr at Hwy 16				6	790	In balsam-spruce forest
93H	Apr 12/76	32	Ridge N of Narrow L				T	835	
93H	Apr 29/76	33	Tumuch Rd - Mi 22				2-3		
93H	May 4/76	34	Raven L		2		14	1680	R. Weinard; signs of cratering
93H	May 7/76	35	Raven L - Wendle Cr				6	884	B. Norheim
93H	May 15/76	36	W. Twin Cr	1	3	1	2	1660	In balsam-spruce forest
93H	May 23/76	37	Ptarmigan Cr	6	4		T	1640	In balsam-spruce forest
93H	May 26/76	38	Severeid Cr				3-5		
93H	Jun 15/76	39	Papoose L				5	810	In cedar forest
93H	Jun 23/76	40	W Fork Ptarmigan Cr				10	1370	R. Weinard & B. Lundquist; in balsam-spruce parkland
93H	Jul 5/76	41	Hungary Cr Rd - Mi 8				T	1275	
93H	Jul 13/76	42	Raven L				2-3		
93H	Jul 14/76	43	Tumuch Rd - Mi 23	1	6		7	1120	Near lake
93H	Jul 19/76	44	Tumuch Rd - Mi 19	1	1		2	1220	M. Bloomfield & R. Weinard
93H	Jul 19/76	45	Above Pass L (OP 16)	1	1	1	3	1070	In cedar-hemlock-spruce forest
93H	Jul 19/76	46	Sande Rd - mi 9				T	1480	M. Bloomfield; in balsam parkland
93H	Jul 19/76	47	Sande Rd - mi 9				3-5		
93H	Jul 19/76	48	Tumuch Rd - mi 19 Trail				T	1490	M. Bloomfield; in meadow
93H	Jul 19/76	49	Sande Rd - mi 9				6-8		
93H	Jul 19/76	50	Pass L				T	1490	M. Bloomfield
93I	Jul 19/76	45					6-10		
93I	Jul 19/76	46					12	1524	Northwood staff; in alpine
93I	Jul 19/76	47		2	2		4	823	Northwood staff
93I	Jul 19/76	48		8			8	823	Northwood staff
93I	Jul 19/76	49					2	1410	M. Bloomfield; subalpine meadow
93I	Jul 19/76	50		1	3	1	5	823	
93I	Jul 19/76	50					2	1370	

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Jul 29/76	51	Longworth Lookout	1		1	2	1525	
93I	Aug 6/76	52	Sande Rd - Mi 10		2	2	4	1070	D. Gall
93I	Aug 15/76	53	Cargill Rd - Mi 20				1	910	
93H	Aug 23/76	54	Raven L				T	1660	M. Bloomfield; timberline meadow
93H	Aug 27/76	55	Raven L		3	1	3-5	1530	M. Bloomfield; balsam-spruce forest
93H	Sep 10/76	57	Raven L		2		2	1560	M. Bloomfield; at timberline
93H	Sep 16/76	58	Goat River				11	1770	In alpine
93H	Sep 18/76	59	Raven L area		2		2	1740	In alpine
93I	Sep 29/76	60	N of Gleason Cr				T2	1680	
93H	Oct 15/76	61	Snowshoe Cr		4		4	1170	In balsam-spruce forest
93H	Oct 19/76	62	Tumuch L	1			1	1370	Poached bull
93H	Oct 21/76	63	W Twin Cr				12	875	
93I	Oct 27/76	64	Hedrick L	1	7		8	1220	
93H	Nov 3/76	65	Grizzly Den				T	1520 -	In subalpine meadow
93H	Nov 6/76	66	Hwy 16 at Purden L				2-3	1550	
93H	Nov 18/76	67	Hungary Cr Tail to Raven L		2		2	860	In cedar-hemlock-spruce forest
93H	Dec 12/76	68	W. Twin Cr at Hwy 16	1	4		T3	1520 -	In balsam-spruce forest
93H	Dec 14/76	69	Legrand Cr				5	1550	
93H	Dec 21/76	70	Hwy 16-20 mi W of W of Ptarmigan Cr	1	8		7	891	In cedar-hemlock forest and licking salt on highway
93H	Jan 7/77	71					9	1010	
93H	Jan 14/77	72	W Twin Cr at Hwy 16				T	800	In cedar-hemlock spruce forest
93H	Jan 18/77	73	Crescent Spur area				3-7	790	In cedar-hemlock spruce forest
93H	Jan 18/77	74	Fleet Cr at Fraser R				7	887	
93H	Jan 18/77	75	Zigzag Ridge between Killam and Kendall Crs				T	980	R. Weinard & M. Bloomfield; in cedar-hemlock-spruce forest
							6-10		
							T	1150	R. Weinard & M. Bloomfield
							3-4		
							T	1570	R. Weinard & M. Bloomfield
							4-5		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev. (m)	Source; Comments
93G	Jan 20/77	76	Buckhorn Rd, 10 mi N of George Mt		3		3	1168 - 1200	
93H	Jan 29/77	77	Clyde Cr				T	1200	
93H	Feb 8/77	78	Red Mt - Penny		11	1	8-12 12	1540 - 1560	In alpine basin
93I	Feb 12/77	79	Fontoniko-Herrick Crs				T	1065	
93H	Feb 25/77	80	Clyde Cr	1	3		2-3 4	1570	
93I	Mar 8/77	81	Sande Rd - Mi 10		2		2	884	
93H	Mar 9/77	82	Hungary Cr at Hwy 16				T	834	In balsam-spruce forest
93H	Mar 20/77	83	Pass L Road - Mi 17		3	1	4-5 4	881	In muskeg
93H	Mar 20/77	84	Dome Cr headwaters		3		4	1710	In alpine
93I	Mar 25/77	85	Herrick Cr-Mueller Cr	1			5	1380	
93H	Mar 26/77	86	Sugarbowl Mt				4	1630	
93I	May 3/77	87	Severeid Cr				T	1450-	In krumholz-alpine area
93I	May 3/77	88	Hedrick Cr				4-7	1500	
93H	May 4/77	89	Hungary Cr			1	2	1670	Along creek
93H	May 5/77	90	W Twin Cr		1		1	747	B. Von Bleker
93H	May 9/77	91	Raven L				1	823	E. Monroe; in cedar-hemlock-spruce forest
93I	May 11/77	92	Herrick Cr-Mueller Cr	2	9		11	1525	Feeding on arboreal lichens
93H	May 14/77	93	Tumuch Rd - Mi 23				?	1360	Small Band in balsam-spruce parkland
93I	May 24/77	94	Severeid Rd (OP 25)				4	834	
93I	May 25/77	95	Tumuch Rd-Mi 8.5		1		1	834	
93I	May 26/77	96	Sande Rd-Mi 9		6		1	1135	
93H	Jun 5/77	97	Dome Cr	1	2		7	671	
93I	Jun 7/77	98	Pass L Rd-Mi 25		2	2	2	1006	In creek bed
93I	Jun 8/77	99	Pass L Rd-Mi 22-25	1	2		4	884	D. Rollet
93H	Jun 7/77	100	Haggen Cr	4	2		3	884	B. Barclay
								1150	R. Weinard, K. Child, K. Fujino; in balsam-spruce forest

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Jun 13/77	101	Pass L		2		2	884	R. Jansen; in balsam-spruce forest
93I	Jun 15/77	102	Mt Severeid		1	1	2	1570	K. Child, R. Weinard, K. Fujino; collected pellets w/placental tissues
93I	Jun 19/77	103	Torpy-W Torpy Rivers				T	836	
93I	Jun 21/77	104	Torpy R Rd (C.P. 9)				3-4		
93H	Jul 5/77	105	Nevin Cr			1	1	793	D. Rollet
93I	Jul 15/77	206	Pass Lake Ridge		4	2	6	1040	In subalpine meadow
93J	Jul 18/77	107	Mt Averil				T	1340	
93I	Aug 12/77	108	Logan Rd - Mi 31	4	1		6-8	1020	B. Norheim; 2 big bulls & 2 small bulls
93H	Sep 3/77	109	Grizzly Den				5	1405	"Much activity in balsam-spruce forest, pellets of 8-12 caribou"
93I	Sep 10/77	110	Pass L Rd - Mi 8.5-9	2	7	2	11	930	
93H	Oct 10/77	111	W Twin Cr				12	850 -	
93H	Oct 12/77	112	Legrand Cr at Hwy 16		4		4	1035	Crossed highway to cedar-spruce stand
93I	Nov 21/77	113	Woodall Cr				2	980	In balsam spruce forest
93H	Dec 17/77	114	Clyde Cr at Hwy 16		3		3	900	At edge of timber
93H	Dec 23/77	115	Sugarbowl Mt				T	1390	In balsam-spruce forest
93I	Dec 27/77	116	Hedrick L				4-5		
93H	Dec 28/77	117	Red Mt - Penny	1	6		7	1560	In subalpine meadow
93H	Nov 3/76	118	Grizzly Den				10-15	990	In cedar-hemlock-spruce forest
93H	Nov 18/76	119	Cut-off trail below Raven				3	1520	Fresh tracks at cabin & in meadow
93H	Dec 12/76	120	West Twin				3	1520	Bloomfield & Hudson ; tracks
93H	Apr 13/77	121	Sugarbowl Mt	1	9	2	12	1680	D. Ferguson
93H	Jul 27/77	122	Peak S of Dome Mt				4	1680	Weinard & Fujino
							7	1830	J. Burbee

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev. (m)	Source; Comments
93H	Mar 18/77	123	Lake W of Dome Cr				6		Bloomfield
93H	Aug 14/75	124	Lake W of Dome Cr						Weinard
93I	Jul 6/77	125	Mt Hedrick		1	1	2		Weinard; tracks
93I	Dec 28/77	126	S side Dezaiko Range				15	1830	Weinard; many tracks
93I	Oct/76 or /77	127	McGregor R (2 locations)	1		1	2	1520	"Dept. of Environment guy", reported by Weinard
								670	"a consultant", reported by Weinard
93I	Jan/78	128	North Herrick		1	1	2	1520	
93H	Apr 4/77	128	West Twin			1	1		
93I	Dec 28/77	130	W Torpy R					880	Killed by wolf
93I	Jul 4/77	131	Ridge N of Torpy R	1			1		
93I	Jul/76	132	W of Harvie Cr		4	2	6	1680	
93I	Jul/76	133	W of Harvie Cr				7	1680	
93I	May 22/77	134	McGregor R				6	1680	
93I	Sep 12/76	135	Herrick Cr, 2 mi below falls				1	670	Renewable Resources consultant
							2	750	Renewable Resources consultant
93I	May 26/76	136	Hedrick Cr				4	1220	Renewable Resources consultant
93I	Apr 25/76	137	Dezaiko Range				5	1520	Renewable Resources consultant
93I	May 3/77	138	Herrick Cr				2	1220	Renewable Resources consultant
93H	Jan 17/79	139	Ridge N of Longworth					1520+	D. King; many tracks
93H	Dec/78	140	West Twin				?		W. & G. Karr, Crescent Spur
93I	Jan 24/79	141	Bearpaw Ridge			1	5	1580	S. & D. Stevenson, R. Weinard; tracks
93I	Jan 24/79	142	Bearpaw Ridge	1		2	9	1490	S. & D. Stevenson, R. Weinard; tracks
93H	Feb 21/79	143	2 mi NW of W Twin Cr						
93H	Feb 21/79	144	E side Zigzag Ridge		1	1	2	1220	S. & D. Stevenson, R. Weinard
93H	Feb 23/79	145	2 mi NW of W Twin Cr		1	1	2	1950	S. & D. Stevenson, R. Weinard
					1			980	S. Stevenson, R. Weinard; tracks
93H	Feb 22/79	146	Sugarbowl Mt				4		R. Weinard
93H	Feb 22/79	147	SE of Sugarbowl Mt						R. Weinard; many tracks
93H	Feb 22/79	148	Raven L				2		R. Weinard; tracks
93H	Feb 22/79	149	Ridge N of Narrows L				5		reported by R. Weinard
93H	Jan/79	150	West Twin & Hwy 16				1		reported by Sherry Neubeck

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Feb/79	151	West Twin & Hwy 16		1	1			reported by Sherry Neubeck
93H	Winter 77/78	152	Boulder Mt (headwaters of Bounding Cr)				4-6		seen by Peter Freeman;
93H	Mar 23/79	153	Ridge N of Narrow L				8	1830	reported by Fredericks S. Stevenson, Weinard, Fujino; tracks
93H	Mar 23/79	154	Raven Lake				2		S. Stevenson, Weinard, Fujino; tracks
93I	Mar 23/79	155	Bearpaw Ridge					1520+	S. Stevenson, tracks of different ages all along ridge
93I	Mar 23/79	156	Bearpaw Ridge		1	1	2	1520+	S. Stevenson, Weinard, Fujino; tracks
93G	Mar 21/79	157	Ridge W of Naver Cr						D. Stevenson; tracks
93H	Apr 3/79	158	Near headwaters Spittal Cr			2	7	2380	K. Fujino
93H		159	Mt Renshaw						K. Fujino
93H	Mar 27/79	160	Sugarbowl			4	11	1680	Weinard
93H	Mar 27/79	161	SE of Dome Mt				2	1680	Weinard
93H	Apr 19/79	162	Sugarbowl				2-4	1680	S. Stevenson, R. Weinard; tracks
93H	Apr 19/79	163	NW of Raven L	1		1	7		S. Stevenson, R. Weinard
93H	May 1/79	164	Sugarbowl		4	2 or 3	7	1680	S. Stevenson, K. Fujino
93H	May 4/79	165	West Twin - 1/2 mi E of Ferguson's cabin	1	2	1	5	910	D. Stevenson
93H	May 7/79	166	3/4 mi NW of W Twin Cr	2			2	910	reported by S. Neubeck
93I	May 26/79	167	Ridge between Captain Cr					1520	S. Stevenson, R. Weinard
93I	May 26/79	168	Ridge of James Cr				3	910	S. Stevenson, R. Weinard
93I	May 22/79	169	McGregor R near Otter Cr				2	2300	Radar (NMH pilot); caribou swimming in river
93H	Jun 1/79	170	Bearpaw Ridge				2	1520	S. Stevenson, Weinard; fresh tracks
93H	May 18/79	171	West Twin				5	910	reported by S. Neubeck
93H	Jun 9/79	172	Sugarbowl	1	1	1	2	1740	S. & D. Stevenson, Weinard; tracks on snow
93H	Jul 13/79	173	Bearpaw Ridge				2-3	880	Don Cuddibank, reported to D. Stevenson

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Jul 13/79	174	Ridge S of Narrow L				2	1740	D. Stevenson, Weinard
93H	Dec 20/79	175	Between Legrand and Clyde		1	1	2	880	Don Cuddibark, reported to D. Stevenson
93I	Feb 24/80	176	Severid Mt					1520	Weinard; many tracks
93I	Mar 19/80	177	Bearpaw Ridge	2	6	2	10	1430	Weinard, Hazelwood; in timber
93H	Apr 28/80	178	Hwy 16 between Goat R and W Twin		1		1	910	M. Vatamaniuk to D. Stevenson
93G	1973	179	Trapping L area					1070	D. Eastman & M. Warren; pellet groups
93J	Nov 15/71	180	E side Barney Cr				2-3	910-1070	D. Eastman; fresh tracks
93H	Oct 8/75	181	Grizzly Den	2			2		Weinard, Child; sedge meadows hunters, reported to Weinard
93H	Oct 24/75	182	Slim mineral lick		2		2		Len Swanson (Dunkley)
93H	Oct 10/75	183	Road near Stony L				10		Neil Thomas
930	Jan 8/75	183A	Hwy 97 & Mackenzie Rd				30		M. Vatamaniuk; hit by car
93H	Jan 14/76	184	Hwy 16 near LaSalle Lks				3	1370-1520	Northwood personnel
93H	Feb 5/76	185	Headwaters of Goat R						N. Thomas; tracks in pine flats
930	Feb 12-13/76	185A	Hwy 97 and Mackenzie Rd						Weinard, Fujino; tracks
93H	Feb 10-12/76	186	Lower slopes E of Grizzly Den						"caribou all over"; Raven L; cabin log
93H	Mar 8/76	187	Raven L				5		on lake; Raven L; cabin log
93H	Mar 9/76	187	Raven L				13		on lake; Raven L; cabin log
93H	Mar 13/76	187	Raven L				5		Raven L; cabin log
93H	Mar 25/76	187	Raven L				10-		E slope between Grizzly Den and Raven L; cabin log
93H	Mar 31/76	187	Raven L				11		W. Aiston?
930	Jan/76	187A	Mackenzie area; Bruce L and Kennedy Landing						Weinard
93H	Mar 18/76	188	Hwy 16 at Hungary Cr				3		Child; caribou pawing in slush
93H	Apr 12/76	189	Raven L				3		of lake

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Jan 31/ 76-77?	190	Red Mt Cr						Jack Beaudreau; groups of 12, 5, 8
93G	Dec/76	191	Buckhorn Rd near Buckhorn L						
93H	Dec 5/76	192	End of Coal Mine Rd near Tsus L				20		Fred Colebank; heading NW toward George Mt
93H	May 20/77	193	Hwy 16, 15 mi W of McBride				?		Bill Barclay; N side of hwy
93H	Jun 12/77	194	Sugarbowl				3	1520- 1770	D. King; tracks
93I	Jun 15/77	195	Ridge E of Pass L					1650- 1830	Child, Fujino, Weinard; heavy tracking, including calf tracks
93J	Jun 22/77	196	Averil Mt, W of FS lookout	1	1?		2	1250	D. Wiebe; in cottongrass/sedge bog
93H	May 30/74	197	Mile 20 Tumuch Rd				3		H. Galeshoot, Russell
93H	May 6/74	198	Don Cr				4, 5 3, 5		K. Hooker
93H	Nov 13/73	199	Hwy 16 and Snowshoe Cr				3		Licking salt on hwy
93H	May 3/74	200	Haggen and Dominion Cr				20		
93I	Jun 21/77	201	Mi 19.5 Pass L Rd (junction w/Torpy)				1		
93H	Nov 26/77	202	Hwy 16 1/2 mi N of Legrand	1	1		2		M. Vatamaniuk
93H	Nov 26/77	203	Near W Twin				5		M. Vatamaniuk; tracks in cedar-hemlock; 2-2 1/2 ft of snow but only inches below trees
93H	Dec 4/77	204	Mile 4-Hungary Cr Rd				2-3		M. Vatamaniuk; crossing hwy N-S
93H	Dec 19/77	205	Hwy 16 and Legrand				7		M. Vatamaniuk
83D	Dec 10/77	206	Canoe watershed, 15 mi S of Valemount	1	1		2		
93H	Dec 31/77	207	Hwy 16 and W Twin				2		Heading toward Fraser R
93H	Jan 16/78	208	Hwy 16 at LaSalle Lks				15		BCR staff; pine flats; frequent sightings
93D	Feb 11/78	209	Between Hwy 97 and Kennedy Siding				27		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
930	Feb 14/78	210	Booth Creek on Mackenzie access				6-7		N. Thomas; wintering in burn
931	Mar 22/78	211	Sinclair Mills (Mi 85)		1				Pregnant cow hit by train
934	Apr 7/78	212	Mi 56 on Bowron Rd in heavy timber towards Raven L				6		Koppe to D. King; also 6 wolves
934	Jun 7/78	213	Sugarbowl				5-6		K. Child
934	Jun 30/78	214	Grizzly Den				1		yearling
934	Jun 30/78	215	Hungary Cr Rd	1			1		descending across clearcut
934	May/78	216	5 mi upriver of Don Cr				6		
931	Sep 14/78	217	Logan Cr		9	1	11		D. Gunn; 9 cows, 1 calf, 1 juvenile
931	Sep 14/78	218	Hedrick L	2	7	2	11		D. Gunn
934	Nov 21/78	219	Hwy 16 and Legrand Cr				2		
93G	Dec 30/78	220	Hwy 97 near Woodpecker				6		G. Rose; crossing hwy 2:30 a.m.
934	Feb 16/79	222	Between Hutton and Longworth		1		1		G. Rose; on Fraser R
934	Mar 11/79	223	Red Mountain	1	2	2	6	1800	includes 1 small antlerless animal
931	Mar 11/79	224	Mouth of Torpy			1	7		Ken Hooker
934	Mar 13/79	225	Between Haggen Cr and Indian Pt Cr				6		Dan Wiebe
93G	Mar 13/81	226	Troll Lk in Tabor Burn				1		Olga Coltman
931	Mar 13/81	227	Morkman Pass				2		Olga Coltman
93J	Oct/81	228	near Averil Mt				T		Schwab and Arthur; tracks and pellets
934	Mar 18/70	229	Story L				T		Harrison and Warren; tracks in pine flats
93F	Feb 1-2/76	230	NE of Nechako Canyon; S Rivers Ranch				60+		K. Child; much tracking, pawing and bedding in pine forests and sedge meadows
93G	Oct/75	231	Willow Rd E of George Mt				"35"		Reported to Lloyd Erickson
934	Jun 16/79	232	1/4 mi N Raven L				3		2 adults; 6' snow; lake frozen

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Feb/81	233	25 km on Pass L road	1			20		reported at scale by Chris Curry
93H	Apr 20/81	234	N side Hwy 16 by Sugarbowl (2 mi W of Hungary)	1?	2	1	4		K. Child; cedar hemlock stand
93H	Apr 14/81	235	Legrand Cr				3		
93H	Apr 16/81	236	W Twin				10		
93H	Apr 16/81	237	Crescent Spur and Loos	2			2		reported by Robin Hoddinott
93H	Dec 6/74	238	Near Dome Cr both sides road				16		Ken Hooker
93G	Dec 8/81	240	Hwy 97 near RR underpass S of Stoner	1	4		5		Seen at midnight by Motorways truck driver
93I	Aug 15/81	241	Saddle S of Jarvis Lks		5	5	10	1830	George Evanoff
93I	Aug 2/81	244	S shore Jarvis Lks	1	1		2	1490	George Evanoff
93I	Nov 28/81	245	NW slope Bearpaw Ridge	2			2	1220	George Evanoff; in clearcut; 70 cm snow; for 3 weeks following, many caribou tracks in timber between 1220 m and timber line
93I	Jul/80	246	Ridge E of Pass 1	4			4	1520	George Evanoff
93I	Jul 1/78	247	Ridge NW of Gleason Cr		4	3	7	1830	George Evanoff
93I	Jul 1/78	248	Ridge NW of Gleason Cr	2			2	1680	George Evanoff
93I	Jul 1/78	249	Ridge NW of Gleason Cr	1			1	1830	George Evanoff
93H	Dec 5/81	250	1 mi W of Twin Cr		1	1	2	910	George Evanoff; heading south
93I	Jan 15/78	251	Lot 3104 SE of Macgregor				2	760	RAB flight map
93I	Jan 15/78	252	Between Otter L and Captain L				2	1430	RAB flight map; subalpine habitat; plentiful tracks
93I	Jan 19/78	253	Between Hominka-Missinka HW, subalpine flat						Few tracks; "Caribou were seen here last winter and also this morning by Ernie Moss - approx 10-12"
93I	Jan 19/78	254	Dezaiko Range subalpine			0	12		RAB flight map
93I	Jan 16/78	255	Dezaiko Range						RAB flight map; tracks
93I	Feb 3/77	257	Upper Hominka						RAB flight map; mod tracks

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Jan 13/78	259	Dezaiko Range				3		RAB flight map; tracks
93I	Jan 13/78	260	Dezaiko Range				19		RAB flight map; (11+5+3)
93I	Jan 14/78	261	E of McGregor	1	1		2	760	RAB flight map; in logged area
93I	Jan 14/78	262	Bearpaw Ridge						RAB flight map; few tracks
93I	Jan 14/78	263	Ridge E of Mt Severeid					1220	RAB flight transcript; tracks
93I	Feb 17 or 18/77	265	Homirko headwaters			2	8		RAB flight map
93I	Feb 17 or 18/77	266	Homirko headwaters						RAB flight map; mod tracks
93I	Feb 19/77	267	Herrick Pass		9	3	12		RAB flight map
93I	Mar 7/77	268	Homirko headwaters				12		RAB flight map
93I	Mar 7/77	269	Mt Dudzic						RAB flight map; few tracks
93H	Jan 14-19/78	277	NW of Longworth						RAB flight map; plentiful tracks
93H	Jan 14-19/78	278	Ridge N of Walker Cr					1830	RAB flight map; tracks
93H	Jan 14/78	279	W of Holy Cross Mt					910	RAB flight map; few tracks
93H	Jan 17/78	280	Bearpaw-Red Mt						RAB flight map; few-mod tracks
93I	Jun 28/80	281	Small ridge NE of Bearpaw	1	4	1	6		G. Hazelwood and Spruce City Wildlife Club
93I	Jun 28/80	282	Bearpaw Ridge	1			1		G. Hazelwood and Spruce City Wildlife Club
93H	May 30/74	284							Child and Fujino caribou flight; tracks only; lots of snow above 1220 m
93H	Feb 6/75	285	Hwy 16, 14 mi W of McBride	1			1		M. Vatamaniuck; killed by vehicle
830	Mar 15/75	286	Mica Mt; SW of Tete Jaune				5		M. Vatamaniuck
830	Jun 20/75	287	E end Moose L in park	1			1		M. Vatamaniuck; feeding in swamp
830	May 15/76	288	Dave Henry Cr				4		M. Vatamaniuck; feeding on slides
93H	Oct 19/76	289	Bell Mt W of McBride	1					M. Vatamaniuck; poached

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Jan 15/77	290	Between Small and Horsey Crs (near Pleasant's Gulf)				5		M. Vatamaniuck
83D	Feb 15/77	291	Dave Henry Cr				7		M. Vatamaniuck; feeding on slides
93H	May 10/77	292	Ferguson property				4		D. Ferguson; heading up W Twin
93H	May 10/77	293	Hwy 16 at Fergusons'				3		D. Ferguson
93H	May 1/77	294	Mouth of Fleet Cr	1		1-yr	1		Nellie Ferguson; tracks
93H	Jun 9/77	295	Ferguson property				4		D. Ferguson; moving north
93I/	May 3/77	296	McGregor and Parsnip Valleys				1		Renewable Resources consultant; tracks only
93I	Mar 31/74	297	Mt Sheba				10		D. Milne (Citizen reporter)
93I	Oct 11/75	298	McGregor near Cargill mouth				2		Reported to Renewable Resources by Ken Child
93I	Sep 22/75	299	Lower Torpy				2		Reported to Renewable Resources by Ken Child
93I	Jun 5/77	300	McGregor Plateau						Child and Fujino; old tracks
93I	Feb 12/77	301	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93J	May 26/77	302	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	May 11/77	303	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	Apr 17/77	304	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	Apr 25/77	305	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	Dec 4/77	306	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	Apr 4/77	307	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	May 2/77	308	McGregor and Parsnip Valleys						Renewable Resources; tracks only
93I	Sep 74-77	309	Parsnip R flats below Arctic L				1		Renewable Resources final map

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Sep 74-77	310	McGregor near Einar Cr				2		Renewable Resources final map
930	Oct 31/74	311	Hwy 97 near Tudyah L				1		Reported to Renewable Resources by Ken Child
930	Winter 74/75	312	Kennedy Flats				25+		Reported to Renewable Resources by Ken Child
930	Summers	313	Ridge E of Pine Pass				26		Reported to D. Stevenson by Azouzetta L resident; repeated summer sightings
93H	Jan 9/82	314	CN tracks between Hutton and Longworth				17		Killed by trains and snowploughs (8+3+6)
9H	Jan 3/82	315	Hwy 16 at Crescent Spur				4		CN employee
93J	Sep/81	316	Olsson Cr area						Old antlers found by K. Child
93H	Jan 12/82	317	Small-Horsey Crs, Lot 111658	1		1-yr	3		Licking salt on hwy 16; M.
93H	Dec 15/81	318	Hwy 16 and Legrand			1-c	4		Vatamaniuck
?	Jan 12/82	319	Goodbrand construction camps; Table R			1	1		M. Vatamaniuck
93H	Apr/80	320	Upper McIntosh-Clyde				65		Reported to K. Child
93I	Mar 9/81	321	Captain Cr						Reported to D. Stevenson by former owner of Sandman Inn, McBride; on snow
93I	May 3/79	322	Bearpaw	4			13		R. Weinard
93I	Lt Dec/81	323	Ice Mt				16	1370	R. Weinard
93I	Early Jan/82	324	Herrick rockcut				2	910	Ben Cook, trapper; reported by R. Weinard
93I	Aug/81	325	Severeid Rd				1		Northwood staff; reported by R. Weinard
93I	Jan 22/82	326	Bearpaw Ridge		1		24+	1370-	Peter Koppe, Northwood, reported by R. Weinard
93I	Jul 3/75	327	Forgetmenot Mt				12	1520	3+5+6+5+5+T2; D. Stevenson, R. Weinard, F. Schwab
93H	Feb 22/82	328	Fraser R near Dome Cr				1+1		K. Fujino and M. Warren; reported by G. Hazelwood; also lots of caribou sign G. Hazelwood; on river ice

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Summer/81	329	E of Dore R				6		Reported to M. Vatamaniuk by guide
93H	Summer/81	330	Upper W Twin Cr				2		Reported to M. Vatamaniuk by guide
93H	Summer/81	331	Upper W Twin Cr				1		Reported to M. Vatamaniuk by guide
93H	Summer/80?	332	Killam Cr				14		M. Vatamaniuk
93H	Summer/81?	333	Loren L				1		Reported to M.V. by guide
83D	Summer/81	334	Dave Henry				14		M. Vatamaniuk
83D	Sep/80	335	Between Windfall & Howard Creeks				25		V. Henderson, MOF, Valemount. In logging slash. Actual count
83D	Summer/81	336	Upper Canoe R				4		M. Vatamaniuk; in swamps west of road end
93H	Feb. 15/82	337	Croydon Station				8	valley bottom	Reported by M. Vatamaniuk by ranch residents
83D	Summer/80	3-102	Between Mt Milton and Clemina				T6-8	1830	M. Vatamaniuk
93I	Mar 11/82	339	Between Table & Hominka R	1		1	9	1310	B. Fuhr, D. Stevenson, K. Fujino;
93J	Mar 11/82	340	N side Table R				7	1310	BS, 30% cover, SW aspect, 1 1/2 - 2 m snow, sinking 6" BF, DS, KF; BS, 30% cover, SW aspect
93J	Mar 11/82	341	Mt Bracey		2		2	1740	BF, DS, KF; alpine, SW aspect
93J	Mar 11/82	342	Burden Peak	1	3		4	1370	BF, DS, KF; BS, 30% cover, NE aspect
93J	Mar 11/82	343	Burden Peak				2	1520	BF, DS, KF; alpine, SW aspect
93J	Mar 11/82	344	Mt Crocker					1520	BF, DS, KF; timberline; W aspect
93J	Mar 11/82	345	S side Woodyadilinka Cr			1	4	1340	B. Fuhr, D. Stevenson, K. Fujino; SB, 40% cover, SW aspect

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93J	Mar 11/82	346	S side Woodyadilinka Cr	1		2	6	1340	BF, DS, KF; BS, 40% cover, W. aspect
93J	Mar 11/82	347	S side Woodyadilinka Cr				4	1340	BF, DS, KF; SW aspect, 1 1/2 m snow
93H	May 1/82	349	2 mi E of W Twin bridge	1	3		4		Danny Aiken
93H	May 28/82	350	Sugarbowl Cr		1		2		Jeremy Campbell; heading N across h'wy.
93J	May 14/82	351	Mouth of McGregor; N side				6		Ben Meisner; 4 W/hard antlers
93I	May 14/82	352	McGregor R 8 mi below Herrick				7		Ben Meisner; 2 W/hard antlers
93I	Jun 12/82	353	N end Arctic Lake				2		seen by fisherman; reported by G. Hazelwood
93J	Dec 20-31/73	354	N end Tacheeda Lakes				8		seen by Boyd Bohler; reported by G. Hazelwood
93J	Dec 25/74	355	N end Tacheeda Lakes				4		
93G	May 4/82	356	Mt S of George Mt; headwaters of George Cr N of Naver				12		Milt Warren
93H	May 1/82	357	Ridge N of Narrows L				7-10		Bill Blaney (Wood Preservatives); in mature timber
93H	May 5/82	358	Hwy 16 between Hungary & Sugarbowl Crs				T		Dave King; tracks several days old;
93H	May 12/82	359	Hwy 16-10 mi W McBride				6-8		crossed highway
93I	May 17/82	360	Headwaters Woodall Cr				6		Barb Beyer (Waste Management)
93H	May 31/82	361	Hwy 16-45 mi E of PG	1					M. Warren; "considerable caribou activity"
93H	Fall /80	363	Lakes N of Clear Mt				1		J. Walker, Great Falls, Mont.
93H	Oct /80	366	Hw of N arm Haggan Cr	1	1	1	T		T. Cushman; many tracks
93H	Fall /76?	367	Ridge betwn N Start&Milk				6+		T. Cushman
93H	Oct /80	368	MacLeod Cr				Many		T. Cushman
83D	Fall /82	369	Upper Dave Henry Cr				3		T. Cushman
							2		G. Foreman (Yellowhead Helicopters); D. Stevenson

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
83D	Fall /82	370	Ridge N of Ptarmigan Cr				4	1980	Yellowhead Helicopters pilot; D. Stevenson
83D	Sep/80	371	Ridge E of Valenmount				T		D. King
93I	Jul 24/76	372	Ridge NE of Bearpaw Ridge	1			1		D. King
93I	Late/78 or Winter/79	373	Hominka River				T		D. King; tracks of a small group
93I		374	Missinka River				T		D. King; tracks of a small group
93I	Winter/75 /76	375	Parsnip R to James Cr				T		D. King; tracks along lakes
93G	Jun 24/78	377	Spring Mt				T2-3		D. King
93G	Feb-Apr/ 77-82	378	George Mt (2 locations)				T2-3		D. King; these are locations where he has repeatedly seen tracks (379 also)
93H	Summers & Late winter	379	Boulder Mt				T6-8		D. King
93H	Summers	380	Bell Mt				T		D. King has seen tracks here - 2 of 6 occasions in summer. Skidoos have not reported caribou here in winter
93H	Aug /79	381	Caledonia Mt				T		D. King; fresh sign (old sign occasions)
93H	Fall 75/76	382	Everett Cr				T		D. King rpt. R. Weinard saw caribou tracks while investigating report of elk bugling
93H	Aug/79	383	Upper Dome Cr				1		D. King
93G	Winter/ 78	384	Bald Mt				6		Seen by snowmobilers on flight to select snowmobiling area
93H	Jul /80	385	SE of Tsus Lake				T		D. King; pellets & tracks on snow
93H	Sep 15/82	386	Dome Mt				T		D. King; summer sign but not fresh

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TUT	Elev.(m)	Source; Comments
93H	Early 79 Summer/or80	387	Upper Holmes R				T		O. King
93H	Summer/77 or 78	388	Between Mt Teare & McBride Pk				T		O. King; this area formerly hunted heavily by McBride
93H	March/79 or80	389	N of Penny				T		O. King; in old cedar stand. Penny residents used to see 6-8 regularly but have not since train collision.
93H	Aug 1 78/9	390	E of Everett Cr				T		O. King
93I	Aug 18/82	391	Jarvis L area	1	1	1	3		O. King; seemed to be fewer than last year
93J	Winter/75	392	Junctn Hominka & Parsnip				3-5		O. King
93I	Early Oct/81	393	SE of Sinclair Mills				1		J. Campoell; running through small black spruce swamp
93H	Sep/82	394	Intersection Mt				50-75		Greg Mutch
93H	Sep/82	395	Forgetmenot Pass				20+		Greg Mutch
93H	Sep/82	396	W side Mt Morkill				10-12		Greg Mutch
93H	Sep/82	397	E side Mt Morkill				10-12		Greg Mutch
93H	Sep/82	398	N side Big Shale Hill				10-12		Greg Mutch
93H	Sep/82	399	Headwaters of Chalco				1		Greg Mutch
93H	May-Oct/81	400	Locations of F3						J. Edmonds (Alberta F&W)
93H	Jun-Sep/82	401	Locations of F3						J. Edmonds
93H	Sep-Oct/81	402	Locations of F6						J. Edmonds
93H	Oct 12/82	403	Location of F6				25		J. Edmonds; in rutting group
93H	May-Jul/81	404	Locations of F7						J. Edmonds
93H	Jun/81	405	M5 found dead, Big Shale Hill						J. Edmonds; wolf kill
93H	Jun-Jul/81	406	Locations of M7						J. Edmonds
93H	May-Aug/81	407	Locations of M8						J. Edmonds
93H	Jul-Sep/82	408	Locations of M8						J. Edmonds
93H	Jul-Oct/82	408	Locations of M13						J. Edmonds
93H	Sep 30- Oct 1/82	410	Wallop Cr	2	1	1	6		Alberta F&W Rutting Survey
93H	Sep 30- Oct 1/82	411	HW of McGregor R	2	2	1	5		Alberta F&W Rutting Survey

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	May-Sep/81	412	Locations of M9						B. Wynes, Alberta F&W
93I	Jun-Sep/82	413	Locations of M9						B. Wynes, Alberta F&W
93I	Jul 8/77	414	Jarvis Lake		1	1	2		NE Coal Study Caribou Sightings
93I	Jul 20/77	415	SW of Jarvis Lakes		5	4	10		NE Coal Study Caribou Sightings
93I	Jul 19/77	416	Gleason Cr	1	2	1	4		NE Coal Study Caribou Sightings
93I	Jul 19/77	417	HW N Herrick Cr		3	1	4		NE Coal Study Caribou Sightings
93I	Aug 17/77	418	Upper Gleason Cr				5		NE Coal Study Caribou Sightings
93I	Jan 13/78	419	N side Dezaiko Range			1	19		NE Coal Study Caribou Sightings
93H	Nov 18/82	420	Hwy 16 between Small R & Horsey Creek				6-8		Mrs. Ike Mackinnon; reported to M. Vatamaniuk
93H	Jan 23/83	421	Caribou Meadows			2	113+	1430	D. King; sinking a few inches in snow
93H	Nov/82	422	NW end Bearpaw Ridge				5-6	1580	George & Craig Evanoff; caribou seen regularly during this period
93H	Jan 23/83	423	Ridge W of Pass Lake	1			1	1520	Mike Nash & G. Evanoff; many tracks
93H	Feb 28/83	424	Small R and Hwy 16	2		1	7		M. Vatamaniuk; reported by G. Hazelwood
93F	Feb 7-9/74	425	Kenney Dam area				1		"had been there all winter"
83D	Dec/69	426	Mt Fitzwilliam				1		RAB flight; any caribou tracks
83D	Jan, Feb/70	427	SW of Rufus Peak				4		CLI flight; moderate caribou tracks
83D	Jan, Feb/70	428	Upper Hugh Allan Crk				2		CLI flight; moderate caribou tracks
93H	Jan, Feb/70	429	Loren Lake				40		D. Ferguson
93I	Fall /67	430	Bowron Rd to Dewey on Fraser R						S. Wlasitz; caribou regularly seen moving north
93H	Early Winter /67	431	Raven Lake						O.J. Prather; "a few caribou"
93H	Fall/69	432	Littlefield Cr		1	1	2		F. Cushman
93H	Fall/70	433	Upper Littlefield Cr	2			2		F. Cushman

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOI	Elev.(m)	Source; Comments
93H	Jan/75	434	W. Twin Cr				8		D. Ferguson
93H	Mar /75	435	Hwy 16 near Clyde Cr				5		D. Ferguson
93I	Jan 24-28/69	436	NW of Otter Lake				1		CLI flight
		437	Wichcika Cr						CLI flight; few tracks
		438	N of Severeid Cr						CLI flight; few tracks
		439	W of Tsahunga Mt				3		CLI flight
93H	Jan-Feb/69	440	S shore Narrows L				5		CLI flight
93H	Jan-Feb/69	441	Ridge N of Narrows L				4		CLI flights
93H	Jan-Feb/69	442	Spruce Cr				2		CLI flights
93H	Jan-Feb/69	443	W fork Everett Cr				5		CLI flights
93H	Jan-Feb/69	444	Headwaters Ptarmigan Cr				T		CLI flights; few tracks
93H	Jan-Feb/69	445	Ridge W of Goodson Cr				T		CLI flights; few tracks
93H	Jan-Feb/69	446	Upper Torpy				2		CLI flights
93H	Jan-Feb/69	447	E end Purden L				2		CLI flights
93H	Jan-Feb/69	448	Ridge N of Walker Cr				T		CLI flights; few-moderate tracks
93H	Jan-Feb/69	449	Caribou Meadows				6	1430	CLI flights; few tracks
93H	Jan-Feb/69	450	Sugarbowl Mt				T		CLI flights; few tracks
93H	Jan-Feb/69	451	W of Hungary Cr				5	1520	CLI flights
93H	Jan-Feb/69	452	Holliday Cr				T		CLI flights; few tracks
93G	Jan-Feb/67	453	N of Eulatazella Lake				T		CLI flights; few tracks
93G		454	Upper Cluculz Cr				T		CLI flights; few tracks
93G		455	NW of Titetown Lake				T		CLI flights
93G	/66	456	George Mt				2		Wayne Sharp - after burn but before snowmachines
93H	Sep 15-19/81	457	Caribou Mt				1		T. Cushman
93H	Sep 15-19/81	458	NE of Caribou Mt		1	1	2		T. Cushman
93H	Sep 15-19/81	459	NE of Caribou Mt	1			7		T. Cushman
93H	Sep 20-26/81	460	N Fork Haggan Cr	1			1		T. Cushman

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93H	Oct /80	461	MacLeod Cr	1			1		T. Cushman
93H	Oct /80	462	Headwaters, N Fork Haggen Cr	1			1		T. Cushman
93H	Oct /80	463	Ridge N of Haggen Cr	1			1		T. Cushman; heard rutting bull
93H	Oct 6- 10/83	464	Headwaters, Littlefield Cr	1			1		T. Cushman
93H	Oct 6- 10/83	465	Headwaters, Dominion Cr	1			1		T. Cushman; maybe same bull as 464
93H	Oct 10/83	466	N Fork Haggen Cr	1			1		T. Cushman; immature bull
93H	Sep 14/83	467	Moose Pass				4	2100	B. Little
93H	Sep 14/83	468	Moose R				1	1900	B. Little
93H	May 1/80	469	S slope Mt Hammel				T	1950	Region 5 flight
93H	May 1/80	470	Clear Mt				T	1930	Region 5 flight
93H	May 1/80	471	Between Clear Mt and Indian L				T		Region 5 flight; caribou tracks pretty well everywhere
93I	Jul/77	472	Hedrick L area	4	11	5	20		Letter from D. Gunn to K. Child
93I	Jul/77	473	Hedrick L area	3	8	4	15		Letter from D. Gunn to K. Child
93I	Jul/77	474	Head of Logan Cr				7		Letter from D. Gunn to K. Child
93I	Sep/77	475	Logan Cr area, up high	2	9	4	15		Letter from D. Gunn to K. Child
93I	Sep/77	476	Hedrick L	2	14	5	23		Letter from D. Gunn to K. Child
93I	Sep/77	477	Between Gleason and Hedrick Cr	1	7	4	13		Letter from D. Gunn to K. Child

Region 7 (Peace subregion)

Summary of Information Sources:

1-7	CLI flight Jan. 24-28/69
8-17	RAB flight maps and transcripts; NE Coal Study
18-20	Misc.
21-22	B. Wynes; Alberta Fand W., Grande Prairie
23-102	RAB flight maps
103-128	NE Coal Study caribou sightings (F and W Branch files, Fort St. John)
129-134	F. Harper
135-139	Petro-Canada 1981 (locations approximate)

Caribou Sightings:

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Jan 24-28/69	1	W of Wapiti L						CLI flight; few tracks
93I		2	N of Ptarmigan Mt						CLI flight; mod tracks
93I		3	Winfrey Cr				3		CLI flight
93I		4	Holtlander Cr						CLI flight; few tracks
93I		5	Hiding Cr				3		CLI flight
93I		6	S. Redwillow R				5		CLI flight
93I		7	Calliou L						CLI flight; few tracks
93I		8							
93I	Feb 1/77	9	Kinuseo & Onion Crks						RAB flight map
93I	Aug 10/76	10	Quintette Mt				2	1520	RAB flight map
93I	Dec 12/77	11	S Redwillow R		3		3	1040	RAB flight map
93I	Mar 10/77	12	Peak S. of Onion L		5	3	8		RAB flight map
93I	Mar 10/77	13	Muindk Mt			1	1		RAB flight map
93I	Mar 10/77	14	Mt Minnes		1	3	7		RAB flight map
93I	Mar 10/77	15	N side Saxon Ridge				T-6		RAB flight map
93I	Nov 30/76	16	W of Quintette Mt				8		RAB flight map
93I	Dec 1/76	17	NE of Hook L				T-7		RAB flight map
93I	Aug 16/81	18	Ridge N of Moonias Cr	1			1	1980	George Evanoff
93I	Aug 20/81	19	Ridge between Moonias Cr and Harrington Cr	2			2	1980	George Evanoff
93I	Jun /82	20	S end Kakwa L				2-3		Reported by D. King by Olga Coltman. According to Phil Jarman, helicopter pilot, 5-6 C are often seen around Kakwa & Babette Lakes
							T6-8		B. Wynes, Alberta F&W
									B. Wynes, Alberta F&W
									RAB Flights
									RAB Flights
									RAB Flights
93I	May-Sep/81	21	Locations of M9						
93I	Jun-Sep/82	22	Locations of M9						
93I	Oct 19-20/76	23	W of Murray R				T3		
93I	Oct 19-20/76	24	HW Wolverine R				T9		
93I	Oct 19-20/76	25	E of Hook L				T6		

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Oct 19- 20/76	26	N of Hook Cr				T5		RAB Flights
93I	Oct 19- 20/76	27	HW Babcock Cr				T5		RAB Flights
93I	Oct 19- 20/76	28	W of Quintette Mt			2	10		RAB Flights
93I	Oct 19- 20/76	29	Onion L	1			1		RAB Flights
93I	Oct 19- 20/76	30	Between Onion & Wapiti L				T		RAB Flights; few or moderate tracks
93I	Oct 19- 20/76	31	Wapiti L				3		RAB Flights
93I	Oct 19- 20/76	32	SW of Mt Becker				T		RAB Flights; few tracks
93I	Oct 19- 20/76	33	Ochak Mt				T8		RAB Flights
93I	Oct 19- 20/76	34	Belcourt Cr				T		RAB Flights; few tracks
93I	Oct 19- 20/76	35	Belcourt Cr				T		RAB flights; plentiful tracks
93I	Oct 19- 20/76	36	S of Secus Mt				T		RAB flights; few tracks
93I	Dec 14, 18,19/76	37	Ptarmigan Mt				T		RAB flights; few tracks
93I	Dec 14, 18,19/76	38	Wolverine R				T1		RAB flights
93I	Dec 14, 18,19/76	39	N of Hook L				T		RAB flights; few tracks
93I	Dec 14, 18,19/76	40	Hook Cr				T3		RAB flights
93I	Dec 14, 18,19/76	41	Babcock Cr				T		RAB flights; few tracks
93I	Dec 14, 18,19/76	42	HW Babcock Cr		5		7		RAB flights

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Dec 14, 18,19/76	43	Dokken Cr				2		RAB flights
93I	Dec 14, 18,19/76	44	Saxon Ridge				6		RAB flights
93I	Dec 14, 18,19/76	45	E of Saxon Cr			1	7		RAB flights
93I	Jan 21- 22/77	46	Alberta Plateau				T		RAB flights; few tracks
93I	Jan 25- 26/77	47	Muinok Mt			1	1		RAB flights
93I	May 24/77	48	W of Quintette Mt				5		RAB flights
93I	May 24/77	49	W of Quintette Mt				3		RAB flights
93I	May 24/77	50	W of Quintette Mt				T		RAB flights; few tracks
93I	May 24/77	51	S of Saxon Cr				T		RAB flights; few tracks
93I	Sep 18- 20/77	52	NE of Onion L	1	2	1	4		RAB flights;
93I	Sep 18- 20/77	53	NW of Wapiti L	1	2	1	4		RAB flights
93I	Sep 18- 20/77	54	W of Wapiti L	1	1	1	3		RAB flights
93I	Sep 18- 20/77	55	SW of Wapiti L	2			2		RAB flights
93I	Oct 2-3/77	56	Wolverine Cr	1			2		RAB flights
93I	Oct 2-3/77	57	Onion L				T		RAB flights; few tracks
93I	Oct 2-3/77	58	Belcourt L				T3		RAB flights
93I	Oct 2-3/77	59	SW Manitou Mt				T5		RAB flights
93I	Oct 2-3/77	60	SE Manitou Mt				T6		RAB flights
93I	Oct 2-3/77	61	Naraway R.				8		RAB flights
93I	Oct 2-3/77	62	E of Tim Mt				6		RAB flights
93I	Oct 2-3/77	63	Moontas Cr	1	3		T8		RAB flights
93I	Oct 2-3/77	64	Cheval Hill				4		RAB flights
93I	Oct 2-3/77	65	Mt Minnes	2	2	2	6		RAB flights
93I	Oct 2-3/77	66	Mt Minnes				T14		RAB flights
93I	Jul 19/82	67	Top of Spieker Mt				1		Highland Helicopter pilot

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93I	Mar 24-28/66	68	Sukunka R				T		CLI flight; few tracks
93I	Mar 24-28/66	69	Perry Cr				T		CLI flight; few tracks
93I	Mar 24-28/66	70	Between Flatbed Cr & Murray R				T		CLI flight; few tracks
93I	Mar 24-28/66	71	E of Tumbler Ridge				T		CLI flight; few tracks
93I	Mar 24-28/66	72	NW of Hourglass L				6		CLI flight
93P	Jan 21-22/77	73	NE of Mt Chamberlain						RAB flight
93P	Jan 21-22/77	74	Bullmoose Cr						RAB flight; few tracks
93P	Jan 21-22/77	75	Bearhole L				T10		RAB flight
93P	Feb 17-18/77	76	Mt Spieker				16		RAB flight
93P	Mar 7-10/77	77	Bullmoose Mt				9		RAB flight
93P	Mar 7-10/77	78	HW Bullmoose Cr				13		RAB flight
93P	Jan 24-26/77	79	Mt Chamberlain				5		RAB flight
93P	Jan 24-26/77	80	Mt Chamberlain				T		RAB flight; few tracks
93P	Jan 24-26/77	81	Bullmoose Mt				10		RAB flight
93P	Jan 24-26/77	82	W of Mt Crum				T4		RAB flight
93P	Jan 24-26/77	83	Mt Spieker				T		RAB flight; few tracks
93P	Dec 18/76	84	Sukunka R				T3		RAB flight
93P	Dec 18/76	85	Mt Chamberlain				8		RAB flight

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93P	Dec 18/76	86	S of Mt Collier				T		RAB flight; few tracks
93P	Dec 18/76	87	S of Wolverine R				T7		RAB flight
93P	Nov 16-30, 88		Rocky Cr				T5-15		RAB flight
	Dec 1/76								
93P	Nov 16-30, 89		N of Mt Wendt				T15-20		RAB flight
	Dec 1/76								
93P	Nov 16-30, 90		Two Cr				T4		RAB flight
	Dec 1/76								
93P	Nov 16-30, 91		Wolverine				T		RAB flight; few tracks
	Dec 1/76								
93P	Jan 24-26/77	92	Trapper				T8		RAB flight
93P	Oct 2-3/77	93	Mt Spieker				21		RAB flight
93P	Oct 2-3/77	94	Mt Spieker				21		RAB flight
93P	Feb 1-3/77	95	Bullmoose Mt area				T		RAB flight
93P	Jan 9/77	96	Burnt R				T		RAB flight
93P	Dec 14 & 16/76	97	Mt Chamberlain				T5		RAB flight
93P	Dec 14 & 16/76	98	Mt Spieker				T3		RAB flight
93P	Oct 19-20/76	99	Mt Reesor				T3		RAB flight
93P	Oct 19-20/76	100	Mt Reesor				T2		RAB flight
93P	Oct 19-20/76	101	Wolverine R				T3		RAB flight
93P	Jun 7, 8, 23/76	102	Mt Palsson				1		RAB flight
93P	Feb 24/76	103	Mt Chamberlain	1	4		5		NE Coal Study Caribou sightings
93P	Jun 8/76	104	S of Mt Palsson				1		NE Coal Study Caribou sightings
93P	Jul 23/76	105	Mt Reesor				1		NE Coal Study Caribou sightings
93P	Aug 19/76	106	Mt Reesor	2	2	1	5		NE Coal Study Caribou sightings
93P	Aug 20/76	107	Mt Reesor	2	2	1	6		NE Coal Study Caribou sightings
93P	Aug 27/76	108	Mt Reesor		1		1		NE Coal Study Caribou sightings

Caribou Sightings, continued

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93P	Oct 19/76	109	Mt Reesor			2	13		NE Coal Study Caribou sightings
93P	Dec 19/76	110	Mt Chamberlain		1	1	2		NE Coal Study Caribou sightings
93P	Jun 11/77	111	Elephant Ridge	3			3		NE Coal Study Caribou sightings
93P	Dec 11/77	112	Bullmoose Cr		1	1	2		NE Coal Study Caribou sightings
931	Jul 30/76	113	Quintette Mt		1	1	2		NE Coal Study Caribou sightings
931	Aug 27/76	114	N of Hook L		1	1	2		NE Coal Study Caribou sightings
931	Jun 21/77	115	NW of Muinok Mt		2	1	2		NE Coal Study Caribou sightings
931	Jul 8/77	116	Upper Wolverine R		1	1	2		NE Coal Study Caribou sightings
931	Jul 8/77	117	Mt Minnes				6		NE Coal Study Caribou sightings
931	Jul 26/77	118	Mt Becker	1			1		NE Coal Study Caribou sightings
931	Jul 27/77	119	SW of Mt Becker	1			5		NE Coal Study Caribou sightings
931	Jul 27/77	120	Bone Mt		1		1		NE Coal Study Caribou sightings
931	Jul 27/77	121	NW of Wapiti L				4		NE Coal Study Caribou sightings
931	Jul 27/77	122	Upper Fellers Cr		1	1	2		NE Coal Study Caribou sightings
931	Aug 7/77	123	E. Ochak Mt	1	1	2	3		NE Coal Study Caribou sightings
931	Sep 5/77	124	N of Mt Bulley	1			1		NE Coal Study Caribou sightings
931	Sep 5/77	125	N of Mt Bulley	1			1		NE Coal Study Caribou sightings
931	Sep 20/77	126	W of Wapiti L	1		1	5		NE Coal Study Caribou sightings
931	Oct 3/77	127	W of Quintette Mt	2		1	5		NE Coal Study Caribou sightings
931	Oct 3/77	128	S of Onion L		2	1	5		NE Coal Study Caribou sightings
931	Jun 5/81	129	HW Babcock Cr				1		F. Harper
931	Jun 5/81	130	HW Babcock Cr				6		F. Harper
93P	Jun 5/81	131	Sheriff Mt		3	3	3		F. Harper
93P	Jan 30/82	132	Bullmoose Cr				1		F. Harper
93P	Mar 19/82	133	Spieker Mt				1		F. Harper; caribou dead
93P	Mar 19/82	134	W. of Mt Collier		3	1	6		F. Harper
93P	No Date (Probably Winter)	135	Dokken Cr				5		Petro-Canada 1981
93P	No Date (Probably Winter)	136	S of Dokken Cr				1		Petro-Canada 1981
93P	No Date (Probably Winter)	137	S of Dokken Cr				1		Petro-Canada 1981

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
93P	No Date (Probably Winter)	138	W of Quintette Mt				5		Petro-Canada 1981
93P	No Date (Probably Winter)	139	Kinuseo Cr area				T		Petro-Canada 1981; any tracks

Region 8

Summary of Information Sources:

1-3	CLI Flights: Jan. 5-Feb. 2/68
4-8	T. and C. Crowley
9-21	A. Frisby
22-24	Penticton Fish and Wildlife Branch staff

Caribou Sightings:

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82L	Jan 5-Feb 8/68	1	HW Sitkum Cr				T		CLI Flights; few tracks
82L	Jan 5-Feb 8/68	2	Monashee Prov Park				3		CLI Flights
82L	Jan 5-Feb 8/68	3	Monashee Prov Park				T		CLI Flights; few tracks
82L	Fall/81	4	Hunters Range				Tlor2		Reported to C. Crowley by Henry Wallenstein (location rough)
82L	Sep/72	5	Hunters Range				11		Reported to Crowleys by E. Doveyduke of Enderby; seen while herding cattle
82L	Jul/74	6	Upper Tsuius Cr				2		Reported to Crowleys by Jim Mack
82L	Aug/77	7	E of Monashee Park	1	1	1	3		T. & C. Crowley
82L	Aug/73	8	Mt Thor				22		T. Crowley. Seen by Kootenay Mountaineering Club
82L	Mar/77	9	S of Greenbush L				3		A. Frisby; in spruce forest. Caribou moved over Blanket Mt
82L	No Date	10	Lake S of Joss Mt				3		A. Frisby
82L	Aug/?	11	Gates L				Sign		A. Frisby
82L	Aug/66	12	Lake W of Mt Symonds	2	3	1	6		A. Frisby
82L	Aug/66	13	N of Monashee Park				7		A. Frisby
82L	Aug/66	14	Monashee Park				27		A. Frisby. 27 caribou in several groups in Park on one day. Nos. 12 & 13 do not necessarily represent different animals.
82L	Early Summer/71	15	Wap L		2		2		A. Frisby
82L	Early Summer/73	16	Wap L	1			1		A. Frisby
82L	No Date	17	Joss Mt				Sign		A. Frisby; in spruce stand
82L	Fall/81	18	N of Moss Mt				T2		A. Frisby

Caribou Sightings, concluded

Map	Date	No.	Location	M	F	J	TOT	Elev.(m)	Source; Comments
82L	No Date	19	Ridge N of Peters L						A. Frisby; has seen caribou there more than once
82L	/54	20	Near Kettle R				3		A. Frisby; drinking from pothole by road
82L	Mid Winter/53	21	Hwy 6 near Inonoaklin Mt				T7		A. Frisby saw tracks of 7 crossing road going NE. Another person saw them a week earlier, heading SW. Caribou reported to D. Jones by Vernon helicopter pilot - Biggs.
82L	No Date	22	Between Gates Cr & Greenbush L						Seen by J. Meesen, Kamloops
82L	Sep/80	23	NW end Peters L						Seen by C. Bull, Penticton fisheries
	Sep/80	24	HW of Ledge Cr						
							Sign		

APPENDIX 2. Forest cover types within caribou ranges

IM	Immature
CH	Mature cedar - hemlock
SB	Mature spruce - balsam
PL	Mature lodgepole pine
FIR	Mature Douglas-fir
PW	Mature white pine or white-barked pine
DEC	Mature deciduous
RES	Residual
NSR	Not sufficiently restocked
NC	Non-commercial timber
DSD	Disturbed, stocking doubtful
A	Alpine
AF	Alpine forest
NP	Non-productive forest
SW	Swamp
W	Water
OR	Open range
ROC	Rock
OTH	Other

Source: Mark IV data base, Inventory Branch, B.C. Ministry of Forests.

Note: Caribou ranges used for the Mark IV analysis are indicated by number on the Caribou Range Maps (this volume). Because the areas for Mark IV analysis were defined by a grid system (Vol. 1, Section 2.1.1), their boundaries do not correspond exactly to the boundaries shown on the Caribou Range maps.

APPENDIX 2, continued

Caribou range	Forest cover types (ha)																TOTAL
	IM	CH	SB	PL	FIR	PW	DEC	RES	HGR	HC	DSD	A	AF	HP	SW	W	
1 Selma-Creston	2878	121	4450						1286	101	459	2406	2449	890			15555
2 Mt Skelly	1899	216	848	62				4		242	13	902	1020	508		470	6201
3 Grassy-Old Baldy									not available								
4 Gray Creek	347	147	702	25		138			1		6	156	1634		17	3	3205
5 Hamling Lakes	518	73	2113	33					15		67	1115	742	575	19	91	5529
6 Hobbs Cr-high	1859	782	2862		66	53			97		145	3775	682	172		21	10546
7 Hobbs Cr-low	2750	966	80	126	265				50		129	17		146		219	4796
8 Greenbush	350	348	539									1038	341	146		189	3407
9 Corbin Pass	604	78	208						36		350	395	549	159		5	2601
10 Mt Carson		2	49									539	115			1	706
11 Mystic Mt												203	19			1	227
12 Kirkup	134	198	812						73		71	71	202				1801
13 Frisby Ridge-low	156	28	217		42				16		21		1			51	534
14 Frisby Ridge-high	149	1433	911		113				18		70	910	1781	65		16	5486
15 Eagle Pass Mt	1246	81	1658						248	32		2533	591	154		174	6800
16 Anstey Ridge	1	58	573									302	414			2	1351
17 Pettipiece Pass	9	172	716									1003	1847	4		110	3926
18 Ratchford Creek	1127	2764	350						389		6	4	147	6	15	42	5043
19 Bischoff Lakes	1242	144	3952					60	429		125	3162	756	155	195	223	10577
20 Rag Christie Ridge	1227	21	2206						133		60		177		170	9	4013
21 Wire Cache Saddle	323	415	404		42			47	67		31						1335
22 Gold Creek	1116	354	242						152	5	26	10		15	20	42	2002
23 Tustum Lake	109	556	391						4					5			1350
24 Groundhog Mt	1754	51	6661	157			45		90	3	7	571	1128	248	344	87	12405
25 Avila-Peddle	2394	389	12478		15			12	913	54	148		65	302	1702	144	10039
26 Raft-Trophy	1370	255	5722	44	16			3	572	3		4824	1769	242	129	166	15246
27 Raft River W	2028	84	1163		22				145	9		67	399	8	163	23	4425
28 Whitewater Creek	4	397	557						16	2			29	43		12	1073
29 Mileage-low	323	1193	594		101		12			76				403		114	4291
30 Mileage-high	678	559	4079		52	60			67			2833	900	243			9554
31 Mackay-McKusky	535	735	1268	26					133			87	28			105	2955
32 Eureka-McCallum	216		3005	39					719			5182	1111	44		182	10315
33 Big Slide	1930	1044	5406	143	395		21	29	317			720	594	127			10045
34 Hen Ingram Lake	1246	548	94	50	44		28		31					26		537	1025
35 Horsefly Lake	104	1624	171						1					13		346	1405
36 Isaacles Mt	34	30	1943									633	174	54			2951
37 Bill Miner Creek	334	270	572		4									24		91	1366
38 Junction-high	2739	3134	10185	128	49		51		94	25		13623	3607	535		311	34893
39 Junction-low	159	4145	408		165				49				8	112		980	8144
40 Mt Matthew	17	27	4805						80	6		6465	961	26		126	12758
41 Ghost Lake	698	156	2861	142					177			129	15	33	218	116	4247
42 Mt Kimball	663	330	3330	184					19	2		892	321	42			5885
43 Stevenson-high	7395	430	29741	3273	148		4		554	34		8560	4791	889		312	50819
44 Stevenson-low	2408	2875	1771	618	200		11		470	2		45	68	77	638	427	9782
45 Yanks Peak-Berkerville*	7273	63	64726	1976	147		38	39	1173	120		3497	2758	999	1044	41	769

APPENDIX 2, continued

Caribou range	Forest cover types (ha)																			TOTAL
	IM	CH	SB	PL	FIR	PW	DEC	RES	NSR	MC	DSO	A	AF	NP	SW	W	OR	OTH		
46 Porter Creek ^a	692		706	185						9				23	13	1			1629	
47 Cunningham	207	1046	1286	41	539		52		314	59				91		100		161	3696	
48 Palmer Range ^a	1456		2630									1398	1205		9			41	6766	
49 Stanley ^a	536		543	106										19	4	5		64	1277	
50 West Twin-high	784	749	9621						512	7	8	6265	592	70				36	18644	
51 West Twin-low	5551	11610	7820	153			382		860	256	32	6		309	705	1032		464	29181	
52 Dome-Haggen	308	232	31977	144					308	152		18680	2479	331		636		318	55565	
53 Slim Creek	1839	1964	4436	3			8	57	503	157		44		76	207	270		1	9565	
54 Sugarbowl-Raven	153	166	13761						122	30		950	1269	17				89	16557	
55 Marrow Lake Ridge	244		11433		106				374	18		454	407	19				46	13103	
56 George Mt	4733		20562	72			2		1486	72		496	1396	11				291	29122	
57 Walker-Macgregor	33	5	4227						82			4785	1842	85				56	11115	
58 Longworth	6841	4895	3789	200			84	431	89	139		72	69	275		543		476	17903	
59 Bearpaw Ridge	299	841	6124						71	388		5668	2075	251				31	15749	
60 Macgregor Range	170	44	11109						190	208		5484	2552	101				85	15943	
61 Dezaiko Range	100	633	10065				29		845	388		11079	1993	124				228	25483	
62 Arctic Lake	1027		14941				13		442	766		8050	3874	49		306		186	29654	
63 Hominka	29		2675						95	27		3705	114	22				63	6730	
64 Anzac-Table	210		15589						289	245		7495	1553	36				33	25450	
65 Marroway	1103		3640	1309			114		891	64		9264	994	116				143 ^D	17638	
66 Belcourt	3915		4549	4824			5		170	152		15041	2448	160				74 ^D	31338	
67 Redwillow	145		99	1365			10							3010				30 ^D	4659	
68 Hiding	322		118	225			70			32				779				1 ^D	6234	
69 Calliou Lake	1022		435	409			10		4	7				480	16	54		1	2486	
70 Wapiti	1559		1894	182					32	247		1427	805	34				54 ^D	6234	
71 Quintette	3923		1423	80					387	777		4793	1589	302				65 ^D	13336	
72 Bearhole Lake	265		62	1936			7			17				1188	262	276			4013	
73 Splaker-Reesor	1709		6795	203							870	10882	2549	46				96 ^U	25160	
74 Bullmoose Creek Flats	719		562	2406			87		17	16				115	8	38		30	3598	
75 Bullmoose- Chamberlain	422		1650	204					37	2		4684	2205					30 ^D	9235	
76 Sukunka	295		2093						2	11		2185	1234	11				39 ^U	5850	
77 Jilg	476		756						157	24		1288	1087	173				11 ^D	4305	
78 Elephant Ridge	1242		507	626			42		45	144		1074	952	215				42 ^D	4890	
79 Goodrich- Stevenson-Lehudette	926		3409	138					384	16		7199	3641	67				131 ^D	15914	
80 Mackenzie Flats	5914		1249	1148			39		662	235				58	167	264		301	13038	
81 Itche-Ilgachuz	3280		2485	28839								27047	6249	65		412	6352	1114	75161	
82 Fannie-high			2356	328								1668	1651	23	7	32		92	6157	
83 Fannie-low	382		126	1564						1				58	97	131		9	2368	
84 Hansen- Cheslatta-Kenney	3071		1882	9381			702		114					132	448	1065		265	17060	
85 White-eye	1308		224	4425					2	11				37	245	424		2	6678	
86 Telike Range	656	6	1647	56		160						11493	823		36	71		18	14966	
87 Sibola Peak	7		911	222		79						6146	259		34	25			7653	

^aData based on a 1969 survey.

^DValues for SW and W that make up less than 1% of the total are included in OTH.

APPENDIX 3. Caribou habitat mapping using LANDSAT imagery

CARIBOU HABITAT MAPPING
USING
LANDSAT IMAGERY

by

Edward Kent Watson

INTERNATIONAL RANGE REMOTE SENSING LTD.

for

British Columbia

Ministry of Forests

1982

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INTRODUCTION

Five land cover / land use classes were mapped from Landsat imagery. Landsat cibachrome prints at 1:250,000 were used to map clearcut logging, partial cut logging, mature conifer forest, immature conifer forest and "other" areas (Figure 1).

LITERATURE REVIEW

Murtha and Watson (1975) used a Colour Additive Viewer to map forest clearcuts, and mature and immature forests on southern Vancouver Island.

Watson (1981a) mapped the Canadian portion of the Flathead drainage basin in south eastern British Columbia using a 1:250,000 Landsat cibachrome image as a data base. Map boundaries were transferred to a 1:125,000 topographic map base using a Bausch and Lomb Zoom Stereo Transfer Scope.

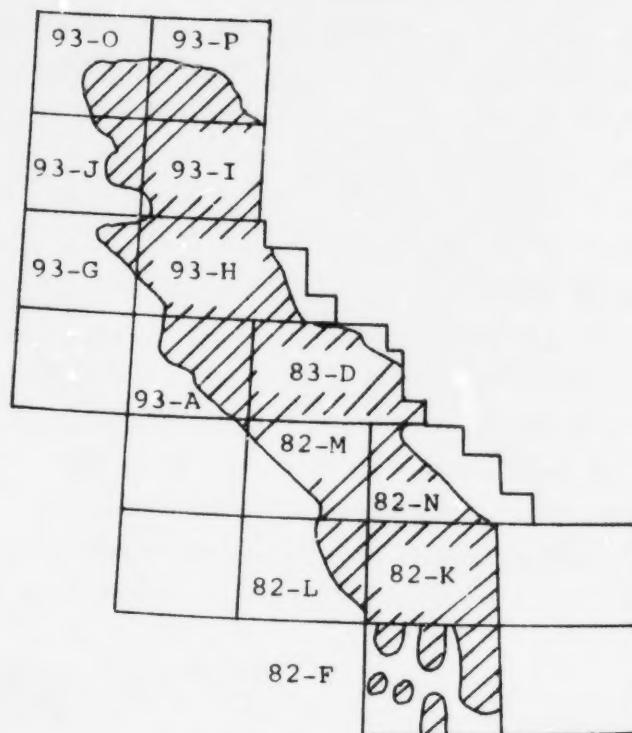
Watson (1981b) used a Colour Additive Viewer to map land use and land cover classes in the Sayward forest area on northeastern Vancouver Island.

MATERIALS AND METHODS

Thirteen Landsat images and thirteen 1:250,000 National Topographic Series Maps were supplied by the British Columbia Ministry of Forests. A sheet of Draftar mylar was placed on each topographic map. The outside map boundaries, major lakes and rivers were delineated. The mylar was superimposed on the Landsat imagery and units were outlined using a .13 mm mars drafting pen.

The imagery, while at 1:250,000, was slightly distorted. Using the predrafted lakes and rivers as control the mylar was shifted so that rivers and lakes corresponded with those of the imagery. Generally, areas of 15 x 15 cm were mapped accurately before slight movement of the mylar was required.

The most recent 1981 images were mapped first and the 1979 images were used where required. The 1977 images were used only when 1979 or 1981 images did not cover the area.



93-O	Mackenzie	83-D	McNaughton Lake
93-P	Dawson Creek	82-M	Seymour Arm
93-J	McLeod Lake	82-N	Golden
93-I	Monkman Pass	82-L	Vernon
93-G	Prince George	82-K	Lardeau
93-H	McBride	82-F	Nelson
93-A	Quesnel Lake		

Shaded zone indicates mapped area.

FIGURE 1. Location map for LANDSAT mapping.

The maps were hand labelled and the legend was typed onto the mylar. A paper copy was produced of each map. Each unit was coloured to determine if each polygon had been labelled. Errors were then corrected.

RESULTS AND DISCUSSION

The imagery was placed in three broad groups. The 1981 imagery was obtained in August and was of excellent quality. The 1979 imagery was obtained during September and, while the quality was good, shadows resulting from low sun angle posed image interpretation problems. The above 1:250,000 Landsat imagery was produced by the Prince Albert Satellite Receiving Station.

The third group of images was produced in Ottawa. The two images in that group did not have the colour contrast required to easily separate the five classes. Also the imagery was not at a scale of 1:250,000 but at 1:234,000 which presented major mapping difficulties.

The mapping method outlined was fast and efficient. Units were placed in correct position within limits determined by Landsat imagery resolution and mapping scale. Using this technique eliminated using a transfer scope which would have added more time and expense to the project.

Paper prints and additional mylars can be produced from the original mylar maps. Note that copies produced from the originals may not be at precisely the same scale since some distortion occurs in the reproduction stage. It is suggested that duplicate mylars be produced on a vacuum unit.

An alternate method to the one employed would be to draft units directly onto mylars produced from 1:250,000 topographic map sheets. This would eliminate the problem of scale change during map reproduction in that the units and topographic base are on the same mylar. It currently costs about \$100.00 to have a mylar produced from a 1:250,000 topographic map.

THE CLASSES

- 1 Clearcut Logging. Clearcuts were the easiest units to identify on the imagery. Small cut blocks occurring in close proximity were sometimes

mapped as one unit and classified as partial cut logging. Clearcuts ranged in hue from blue to bright red for non-vegetated and vegetated clearcuts respectively on the August 1981 imagery. Cut block colours ranged from blue to red, yellow and white on the September 19 imagery. The yellow hues indicate deciduous vegetation which had turned red visually. The white areas within clearcuts suggest deciduous vegetation which had turned yellow or high reflectance from bare soil areas. Areas mapped using the 1979 imagery will not be up to date with respect to clearcut numbers. Substantial increase in cutting was noted in some areas between 1979 and 1981.

- 2 Partial cut. This class included selective logging and any other logging system leaving significant amounts of mature residual timber. These units were easily delineated since mature residual timber stands appeared as dark reddish brown patches within cut over areas. These units were most commonly found in the Prince George area.
- 3 Mature Conifer. This class was easy to map on east, south and west slopes. The main interpretation difficulty occurred on heavily shadowed north slopes. Interpretation was easier on the August 1981 imagery than on the September 1979 scenes because the former had higher sun elevations which provided better illumination on the north slopes.
- 4 Immature Conifer. This was the most difficult class to map, especially in mountainous terrain. Problems occurred while attempting to separate immature forest from deciduous avalanche areas and subalpine slopes. Deciduous stands are included in this class. Immature conifer forest, avalanche areas, brush and deciduous forests were bright red on the images.
- 5 Other. This class consisted primarily of snow, ice, alpine grasslands, avalanche areas, large floodplains and populated areas. There may be

areas of immature conifer forest included in this class in the mountainous areas. This is a result in similarity of colour between immature conifer forest and deciduous areas on lower mountain slopes. Field work would provide better boundary placement between immature conifer forest and other classes.

Within any map unit there may be inclusions of other units. Composite units were not used. Where mixed units occurred the dominant class was applied to the unit.

THE MAPS

Unit boundaries are thin unbroken lines (Figure 2). Hand labelled numbers within the units are the class numbers. Rivers commonly formed the boundary between units. Heavy solid lines delineate the map areas. Thin straight broken lines designate the Landsat image boundaries within a map sheet. The large bold numbers indicate the Path and Row coordinates of the imagery used for each map sheet. Some cloud cover was present over some areas. These occurrences were designated with dashed lines and labelled as cloud covered areas. In most cases more than one Landsat image was employed in mapping one topographic map sheet (Table 1).

FIGURE 2. Example of LANDSAT mapping.

TABLE 1. Map sheets and corresponding LANDSAT imagery employed to map each topographic sheet

Map Sheet	Path & Row	Image Date
Mackenzie 93-O	53 - 21	August 17, 1981
Dawson Creek 93-P	53 - 21	August 17, 1981
	51 - 22	September 18, 1979
	48 - 24	September 20, 1976
McLeod Lake 93-J	52 - 22	August 16, 1981
Monkman Pass 93-I	52 - 22	August 16, 1981
	51 - 22	September 13, 1979
Prince George 93-G	52 - 22	August 16, 1981
	51 - 23	September 13, 1979
McBride 93-H	52 - 22	August 16, 1981
	50 - 23	August 14, 1981
	51 - 23	September 13, 1979
	51 - 22	September 13, 1979
Quesnel Lake 93-A	50 - 23	August 14, 1981
	50 - 24	August 14, 1981
	51 - 23	September 13, 1979
McNaughton Lake 83-D	50 - 23	August 14, 1981
	49 - 23	August 13, 1981
	49 - 24	August 13, 1981
Seymour Arm 82 - M	49 - 24	August 13, 1981
Golden 82-N	47 - 25	August 11, 1981
	48 - 24	August 15, 1977
Vernon 82-L	48 - 25	July 18, 1979
	48 - 24	August 15, 1977
Lardeau 82-K	47 - 25	August 11, 1981
	48 - 24	August 15, 1977
Nelson 82-F	47 - 25	August 11, 1981
	47 - 26	August 11, 1981

SUMMARY

Landsat imagery was used to operationally map five land use and land cover classes for a caribou habitat study. Thirteen 1:250,000 topographic map sheets were mapped using Landsat imagery.

Major lakes and rivers from each topographic map were drafted onto a sheet of mylar. The mylars were superimposed on the imagery and polygons were delineated. Areas of 15 x 15 cm were mapped before a slight movement of the mylar was required to account for the slight distortion in the Landsat imagery.

The 1981 images were mapped first and the 1979 and 1977 scenes were used only when required. The former two dates were excellent quality while the latter was poor.

Clearcut and partial cut logging classes were easily recognized and delineated. Some interpretation difficulty occurred on heavily shadowed north slopes when mapping mature conifer forest. Shadows were more prevalent on September 1979 scenes than on August 1981 images. Immature conifer forest was the most difficult class to map. Problems occurred while attempting to separate immature forest from avalanche areas and subalpine slopes because they were all similar hues.

The method used in this project was quick to provide map results because a transfer and redrafting stage was eliminated. Accuracy was considered good to excellent depending on classes being mapped.

REFERENCES

- Murtha, P.A., & E.K Watson. 1975. Mapping of forest clearcutting, South Vancouver Island, from Landsat imagery. Proc. Third Can. Symp. Remote Sensing. Can. Aeronautics and Space Inst. Ottawa, Can. pp. 257-263.
- Watson, E.K. 1981a. Land use / land cover upper Flathead drainage basin. Unpublished map and report submitted to B.C. Research, Vancouver, British Columbia. 65 pp.
- Watson E.K. 1981b. Land use and land cover classification and mapping of the Sayward forest using Landsat imagery and a Colour Additive Viewer. Map included. 30 pp.

APPENDIX 4. Historical summary of caribou hunting regulations in British Columbia

Regulations through 1955

As outlined in a recent government publication (B.C. Ministry of Environment, Fish and Wildlife Branch 1979a), the first hunting regulation for caribou in British Columbia, dated 1892, was for the province as a whole, and it specified a 108 day open season (15 September - 31 December), with a bag limit of five animals. The season began on 1 September 1895, increasing the duration to 123 days. By 1914 the bag limit had been reduced to three, and only males were legal game.

Area distinctions first appeared in the regulations in 1918, when a hunting closure which lasted 3 years was instituted for caribou "south of the mainline of the Canadian National Railway," i.e., most of the present study area. That measure was "to protect the remaining herds." In the mid- to late 1920's, the primary change was another bag limit reduction, to two caribou north of the CNR and one to the south. By the 1929-30 hunting season, the open season had been cut back to 108 days, closing two weeks earlier than previously (15 December), and that season pertained province-wide until 1933-34 when the area south of the Canadian Pacific Railway (parts of current Regions 3 and 4) was re-opened, but only for 15 days (15-30 September).

As a rule, throughout the 1930's and most of the 1940's seasons and bag limits changed little from those noted above, and the primary "management areas" for regulation purposes remained the two blocks north and south of the CPR. However, during that period some "electoral districts" were singled out for exceptional treatment, usually closure. Included in that category were the electoral districts of Mackenzie (1929-30 through 1946-47), Skeena (1929-30 through at least 1946-47), and Lillooet (1945-46 and 1946-47). From about 1942-43 on through the 1950's, it was also stipulated that only males over the age of one year were legal game.

The area south of the railway maintained the short, 15-day season in September until 1936-37, at which time both duration and timing were changed (31 days, 1-31 October). Another increase in season length, to 47 days (15 September - 31 October) was applied in 1941-42, and that regulation persisted until 1946-47, changing at that time only to include "that portion of the Cariboo Electoral District east of the Fraser River."

Two major and one minor change to British Columbia hunting regulations were introduced in 1947-48: major -- the season bag limit was reduced to one province-wide, and the Revelstoke Electoral District was included in the long (1 September - 31 December) season previously applied to more northerly districts; minor -- there was a more complicated description of that portion of the Cariboo Electoral District open to caribou hunting, but it was still managed with the remaining area south of the railway.

In 1948-49 the new regulations booklet listed three areas in reference to caribou hunting: 1) the area north of the CNR which, together with the Revelstoke Electoral District, remained open for the long season; 2) the area south of the CPR (except the Revelstoke District), still retaining the short season; and 3) the area between the two railways, including all of present Region 5, that portion of Region 6 and most of Region 7 within the present study area, and most of the area occupied by caribou in current Region 3. That large area was closed to caribou hunting. The closure between the CNR and CPR lines persisted until 1954-55, when that portion of Cariboo west of the Fraser River, but not including Tweedsmuir Park, was reopened for a very short season (16 days, 18 September - 3 October) separate from the other two seasons north of the CNR and south of the CPR. In 1955-56 open seasons were extended to other districts in the "between" area, including what is now Region 5 and the portion of Region 6 in the study area (15 days, 1-15 October). At the same time, Wells Gray Park was reopened to a long season (108 days, 15 September - 31 December), including the first open season for females.

During the period discussed in the above paragraph, the most variable item in the regulations was the status of the Revelstoke Electoral District, which retained the long season with northern districts through 1949-50; was managed back with the areas south of the CPR in 1950-51; was split into two, with the portion north of the CPR given a new (medium-length) season of 77 days (15 September - 30 November) and the portion south of the railway retaining the short season in 1951-52 and 52-53; remained split with the northern section again managed with districts north of the CNR (long season) in 1953-54 and 1954-55; and then was again treated the same over its whole extent, in common with other southern areas, in 1955-56 (81 days, 15 September - 4 December).

In 1956-57, 21 separate "Game Management Areas" were established, and all subsequent regulations and harvest data have referred to those areas or to their successors in subsequent management-oriented subdivisions of the province. Following, by management "region" as currently defined, is a summary of caribou hunting regulations in the study area between 1956 and 1982. The annual bag limit over that period remained at one animal.

Regulations, 1956-1982

Region	GMUP	Years	Seasons ^a			
			Males		Either	
			Dates	Length	Dates	Length
<u>Region 3 (Thompson-Nicola)</u>						
3-34	1956		15 Sep- 2 Dec	79		
	1957				15 Sep- 1 Dec	78
	1958-1959		1 Sep-15 Nov	76	1 Sep-31 Oct	61
	1960-1963				1 Sep- 4 Dec	93-95
	1964		15 Aug-29 Nov	107	29 Aug-29 Nov	93
	1965				28 Aug-29 Nov	93
	1966				3 Sep-27 Nov	86
	1967				16 Sep-31 Dec	107
	1968-1982		N			
3-35	1956-1968			(same as 3-34		
	1968-1970		17 Aug-31 Dec	137-39	14 Sep-31 Dec	109-11
	1971		14 Aug-12 Dec	121	4 Sep-12 Dec	100
	1972		12 Aug-10 Dec	121	16 Sep-10 Dec	86
	1973		15 Aug-25 Nov	103	20 Oct-25 Nov	37
	1974-1976		31 Aug-24 Nov	82-86		
	1977-78		1 Sep-15 Oct	45		
	1979-1982		N		N	
3-36	1956-1963			(same as 3-35)		
	1964				29 Aug-31 Dec	125
	1965				4 Sep-31 Dec	119
	1966				20 Aug-31 Dec	134
	1967				12 Aug-31 Dec	142
	1968-1982			(same as 3-35)		

APPENDIX 4, continued

Region GMUB	Years	Seasons ^a			
		Males		Either	
		Dates	Length	Dates	Length
3-39	1956	1 Oct-21 Oct	21		
	1957-1966		(same as 3-36)		
	1967			2 Sep-31 Dec	121
	1968-1970	31 Aug-31 Dec	123	14 Sep-31 Dec	111
	1971			4 Sep-12 Dec	100
	1972	2 Sep-10 Dec	100	16 Sep-10 Dec	86
	1973	15 Sep- 9 Dec	86	20 Oct- 9 Dec	51
	1974	14 Sep-24 Nov	72		
	1975-1982	N			
3-40	1956-1982		(same as 3-36)		
3-41	1956-1974		(same as 3-40)		
	1975-1982	N			
3-42	1956-1982		(same as 3-41)		
3-43	1956-1978		(same as 3-40)		
	1979-1982	1 Sep-15 Oct	45		
3-44	1956-1982		(same as 3-43)		
3-45	1956-1962			15 Sep-31 Dec	106-11
	1963			31 Aug- 1 Dec	93
	1964			12 Sep-31 Dec	111
	1965-1970			18 Sep-31 Dec	105-11
	1971-1972			18 Sep-12 Dec	86
	1973	15 Sep- 9 Dec	86	20 Oct- 9 Dec	51
	1974-1975	14 Sep-24 Nov	72		
	1976	22 Sep-21 Nov	30		
	1977-1982	N			
3-46	1956-1976		(same as 3-45)		
	1977-1979	22 Sep-15 Oct	24		
	1980-1982	N			

APPENDIX 4, continued

		Seasons ^a			
Region	Years	Males		Either	
GMU ^b		Dates	Length	Dates	Length
Region 4 (Kootenay)					
4-01	1956	15 Sep- 2 Dec	79		
	1957	1 Sep- 1 Dec	92	1 Sep-30 Sep	30
	1958	1 Sep-15 Nov	76	1 Sep-31 Oct	61
	1959	1 Sep-30 Nov	91	1 Sep-31 Oct	61
	1960	1 Sep- 4 Dec	95	1 Sep-13 Nov	74
	1961			1 Sep- 3 Dec	94
	1962	25 Aug- 2 Dec	100	1 Sep- 2 Dec	93
	1963-1964	17 Aug- 1 Dec	107	31 Aug- 1 Dec	93
	1965			28 Aug-28 Nov	93
	1966-67			3 Sep-27 Nov	86
	1968			31 Aug- 1 Dec	93
	1969			20 Sep- 2 Nov	44
	1970			12 Sep- 1 Nov	51
	1971	4 Sep- 7 Nov	65	18 Sep- 7 Nov	51
	1972-1982	N			
4-02	1956-1982		(same as 4-01)		
4-03	1956-1982		(same as 4-01)		
4-04	1956-1982		(same as 4-01)		
4-05	1956-1982		(same as 4-01)		
4-06	1956-1982		(same as 4-01)		
4-07	1956		(same as 4-01)		
	1957	1 Sep- 1 Dec	92	23 Nov- 1 Dec	9
		(Note: Seasons for this and following years, through 1971, apply only to northern portion of unit--the rest closed by special exception.)			
	1958	1 Sep-15 Nov	76	15 Oct-31 Oct	16
	1959	1 Sep-30 Nov	91	12 Sep-31 Oct	50
	1960-1982		(same as 4-01)		
4-08	1956-1982		(same as 4-07)		
		(Note: closure in southern half of unit from 1957-1971 also applicable to this unit.)			
4-09	1956		(same as 4-01)		
	1957-1982	N			
4-14	1956-1982		(same as 4-07, except no partial closures 1957-1971)		

APPENDIX 4, continued

Seasons ^a					
Region	Years	Males		Either	
GMUB		Dates	Length	Dates	Length
4-15	1956-1982		(same as 4-14)		
4-16	1956-1982		(same as 4-14)		
4-17	1956-1982		(same as 4-14)		
4-18	1956-1982		(same as 4-14)		
4-19	1956-1982		(same as 4-14)		
4-20	1956-1982		(same as 4-01)		
4-21	1956-1982		(same as 4-01)		
4-22	1956-1982		(same as 4-01)		
4-23	1956-1982		(same as 4-01)		
4-24	1956-1982		(same as 4-01)		
4-25	1956-1982		(same as 4-01)		
4-26	1956-1982		(same as 4-01)		
4-27	1956-1966		(same as 3-34)		
	1967			2 Sep-26 Nov	86
	1968			31 Aug- 1 Dec	93
	1969			20 Sep- 2 Nov	44
	1970			12 Sep- 1 Nov	51
	1971	4 Sep- 7 Nov	65	13 Sep- 7 Nov	56
	1972-1982	N			
4-28	1956-1982		(same as 4-07)		
4-29	1956-1982		(same as 4-27)		
4-30	1956-1982		(same as 4-07)		
4-31	1956-1982		(same as 4-07)		
4-32	1956-1982		(same as 4-27)		
4-33	1956	15 Sep- 2 Dec	79		
	1957	1 Sep- 1 Dec	92	1 Sep-30 Sept	30
	1958	1 Sep-15 Nov	77	1 Sep-31 Oct	62
	1959	1 Sep-31 Nov	92	1 Sep-31 Oct	62
	1960	1 Sep- 4 Dec	96	1 Sep-13 Nov	75
	1961			1 Sep- 3 Dec	94
	1962	25 Aug- 2 Dec	99	1 Sep- 2 Dec	93
	1963-1964	17 Aug- 1 Dec	105-6	31 Aug- 1 Dec	88-92
	1965			28 Aug-28 Nov	92
	1966			3 Sep-27 Nov	86
	1967-1982		(same as 4-32)		
4-34	1956-1982		(same as 4-01)		
4-35	1956-1982		(same as 4-01)		

APPENDIX 4, continued

Region	GMUB	Years	Seasons ^a			
			Males		Either	
			Dates	Length	Dates	Length
4-36		1956-1968		(same as 4-33)		
		1969			30 Aug-30 Nov	92
		1970			5 Sep-29 Nov	87
		1971	4 Sep- 7 Nov	65	18 Sep- 7 Nov	51
		1972	9 Sep- 1 Oct	23		
		1973-1974	8 Sep- 7 Oct	29		
		1975-1982	N			
4-37		1956-1974		(same as 4-36)		
		1975-1977	13 Sep- 5 Oct	23		
		1978-1982	10 Sep- 5 Oct	26		
4-38		1956-1966		(same as 4-32)		
		1967-1982		(same as 4-37)		
4-39		1956-1976		(same as 4-38)		
		1977	10 Sep-25 Sep	16		
		1978-1982		(same as 4-38)		
4-40		1956-1982		(same as 4-37)		
Region 5 (Cariboo)						
5-2A		1956	1 Oct-21 Oct	21		
		1957	15 Sep- 1 Dec	78		
		1958-1959	1 Sep-15 Nov	76	1 Sep-31 Oct	61
		1960-1965			1 Sep- 3 Dec	92-95
		1966			3 Sep-27 Nov	86
		1967-1970			2 Sep-10 Dec	100
		1971			4 Sep- 5 Dec	93
		1972	2 Sep-12 Nov	72		
		1973-1974	8 Sep-12 Nov	63-66		
		1975-1982	N			
5-6		1956-1982	N			
5-10		1956-1966	N			
		1967-1970			2 Sep-10 Dec	100
		1971			4 Sep- 5 Dec	93
		1972	2 Sep-12 Nov	72		
		1973-1975	15 Sep-12 Nov	56-59		
		1976-1982	N			
5-11		1956-1982	N			

APPENDIX 4, continued

		Seasons ^a			
Region	Years	Males		Either	
GMU ^b		Dates	Length	Dates	Length
5-12	1956	1 Oct-21 Oct	21		
	1957	15 Sep- 6 Oct	22		
	1958-1959	1 Sep-21 Sept	21		
	1960	20 Sep-16 Oct	27		
	1961	1 Sep-15 Oct	45	30 Sep-15 Oct	16
	1962	1 Sep-31 Oct	61	15 Sep-31 Oct	47
	1963-1965			31 Aug- 1 Dec	93
	1966			3 Sep-27 Nov	86
	1967-1975		(same as 5-10)		
	1976	11 Sep- 5 Nov	56		
	1977-1982	10 Sep-23 Oct	43-44		
5-15A	1956-1974		(same as 5-2A)		
	1975-1976	6 Sep- 7 Nov	63		
	1977-1979	3 Sep-30 Oct	57-61		
	1980	1 Sep-23 Oct	53		
	1981-1982	1 Sep-15 Oct	45		
5-15B	1956-1982		(same as 5-15A?)		
5-16	1956-1982		(same as 5-2A)		
Region 6 (Skeena)					
6-01	1956	1 Oct-21 Oct	21		
	1957-1958	28 Sep-28 Oct	23		
	1959-1960	26 Sep-25 Oct	30		
	1961	1 Sep-15 Oct	45	30 Sep-15 Oct	16
	1962-1963	15 Aug- 2 Dec	109-10	15 Sep-15 Oct	31
	1964	15 Aug-29 Nov	107	12 Sep- 1 Nov	51
	1965-1966	14 Aug-28 Nov	107	11 Sep-28 Nov	80
	1967-1968	12 Aug-26 Nov	107	16 Sep-26 Nov	72-78
	1969	16 Aug-14 Dec	120	13 Sep-30 Nov	79
	1970	15 Aug- 6 Dec	114	19 Sep-15 Nov	58
	1971	14 Aug-28 Nov	107	4 Sep-28 Nov	86
	1972	19 Aug-26 Nov	100	9 Sep-26 Nov	79
	1973-1977	15 Aug-18 Nov	93-96		
	1978-1982	N			
6-02	1956-1982		(same as 6-01)		
6-04	1956-1982		(same as 6-01)		

APPENDIX 4, continued

Region GMU ^b	Years	Seasons ^a			
		Males		Either	
		Dates	Length	Dates	Length
6-09	1956-1968		(same as 6-01)		
	1969	2 Aug-14 Dec	135	13 Sep-30 Nov	79
	1970	15 Aug- 6 Dec	114	5 Sep-15 Nov	72
	1971	14 Aug-28 Nov	107	4 Sep-28 Nov	86
	1972	19 Aug-26 Nov	100	9 Sep-26 Nov	79
	1973-1982	N			
Region 7 (Omineca-Peace)					
7-01	1956-1966	(Split regulations: North of CNR same as 7-03 and south of CNR same as 6-01)			
	1967	12 Aug-26 Nov	107	16 Sep-26 Nov	72
	1968	17 Aug-30 Nov	106	14 Sep-30 Nov	78
	1969	16 Aug-14 Dec	121	13 Sep-30 Nov	79
	1970	15 Aug- 6 Dec	114	5 Sep-15 Nov	72
	1971	14 Aug-28 Nov	107	4 Sep-28 Nov	86
	1972	19 Aug-26 Nov	100	9 Sep-26 Nov	79
	1973-1974	15 Aug-18 Nov	92-95		
	1975-1982	N			
7-02	1956-1966		(same as 6-01)		
	1967-1974		(same as 4-36)		
	1975-1976	15 Aug-15 Nov	93		
	1977	23 Aug-18 Sep	27		
	1978-1982	N			
7-03	1956-1957	1 Sep-15 Dec	107		
	1958-1959	15 Aug-30 Nov	108		
	1960	15 Aug- 4 Dec	113		
	1961	15 Aug- 3 Dec	112	30 Sep-22 Oct	23
	1962-1963	15 Aug- 2 Dec	110-11	15 Sep-15 Oct	31
	1964	15 Aug-29 Nov	107	12 Sep- 1 Nov	51
	1965-1966	14 Aug-28 Nov	107	11 Sep-28 Nov	79
	1967-1974		(same as 7-01)		
	1975-1982		(same as 7-02)		
Note: Holmes River closed area, 1973, 1975 and 1976.					
7-04	1956-1966		(same as 7-02)		
	1967-1982		(same as 7-03)		
7-05A	1956-1975		(same as 7-04)		
	1976-1982	N			
7-05B	1956-1982		(same as 7-05A)		

APPENDIX 4, continued

Region	GMU ^b	Years	Seasons ^a			
			Males		Either	
			Dates	Length	Dates	Length
7-06		1956-1975		(same as 7-04		
		1976	15 Aug-15 Nov	93		
		1977	23 Aug-15 Oct	54		
		1978-1982	N			
7-07		1956-1974		(same as 7-04)		
		1975-1982	N			
7-08		1956-1982		(same as 7-07)		
7-09		1956-1982		(same as 7-07)		
7-12		1956-1982		(same as 7-07)		
7-16		1956-1966		(same as 7-07)		
		1967-1968	1 Aug-26 Nov	118-20	16 Sep-26 Nov	72-78
		1969	2 Aug-14 Dec	135	13 Sep-14 Dec	93
		1970	1 Aug- 6 Dec	128	5 Sep-15 Nov	72
		1971-1972		(same as 7-07)		
		1973	15 Aug-18 Nov	96	6 Oct-18 Nov	44
		1974	15 Aug-15 Nov	93	19 Oct-27 Oct	9
		1975-1982	N			
7-17		1956-1974		(same as 7-07)		
		1975-1976	15 Aug-15 Nov	93		
		1977	23 Aug-18 Sep	27		
		1978-1982	N			
7-18		1956-1976		(same as 7-17)		
		1977	23 Aug-15 Oct	54		
		1978-1982	N			
7-19		1956-1957	1 Sep-15 Dec	106		
		1958-1959	15 Aug-30 Nov	108		
		1960	15 Aug- 4 Dec	112		
		1961	15 Aug- 3 Dec	111	30 Sep-22 Oct	23
		1962-1963	15 Aug- 2 Dec	109-10	15 Sep-15 Oct	31
		1964	15 Aug-29 Nov	107	12 Sep- 1 Nov	51
		1965-1966	14 Aug-28 Nov	107	11 Sep-28 Nov	79
		1967-1968	1 Aug-26 Nov	118-20	16 Sep-26 Nov	72-78
		1969	2 Aug-14 Dec	135	13 Sep-14 Dec	93
		1970	1 Aug-13 Dec	135	3 Oct-13 Dec	72
		1971	1 Aug-12 Dec	134	4 Sep-12 Dec	100
		1972	1 Aug-26 Nov	118	9 Sep-26 Nov	79

APPENDIX 4, concluded

		Seasons ^a			
Region		Males		Either	
GMU ^b	Years	Dates	Length	Dates	Length
7-19 cont.	1973	15 Aug-18 Nov	96	6 Oct-18 Nov	44
	1974	15 Aug-15 Nov	93	5 Oct-27 Oct	23
	1975	15 Aug-26 Oct	73		
	1976-1977	23 Aug-15 Oct	54		
	1978-1982	23 Aug-15 Sep	24		
7-20	1956-1974		(same as 7-19)		
	1975-1982	N			
7-21	1956-1982		(same as 7-19)		
7-22	1956-1982		(same as 7-19)		
7-23	1956-1976		(same as 7-17)		
	1977	23 Aug-15 Oct	54		
	1978-1982	N			
Region 8 (Okanagan)					
8-23	1956	15 Sep- 2 Dec	79		
	1957	1 Sep- 1 Dec	92		
	1958	1 Sep-15 Nov	77	1 Sep-31 Oct	61
	1959	1 Sep-30 Nov	91	1 Sep-31 Oct	61
	1960-1963		(same as 3-34)		
	1964-1970			29 Aug-29 Nov	86-93
	1971			4 Sep-31 Oct	58
	1972	9 Sep- 1 Oct	23		
	1973-1974	8 Sep- 7 Oct	30		
	1975	20 Sep-19 Oct	30		
	1976-1982	N			
8-24	1956-1974		(same as 8-23)		
	1975-1982	N			

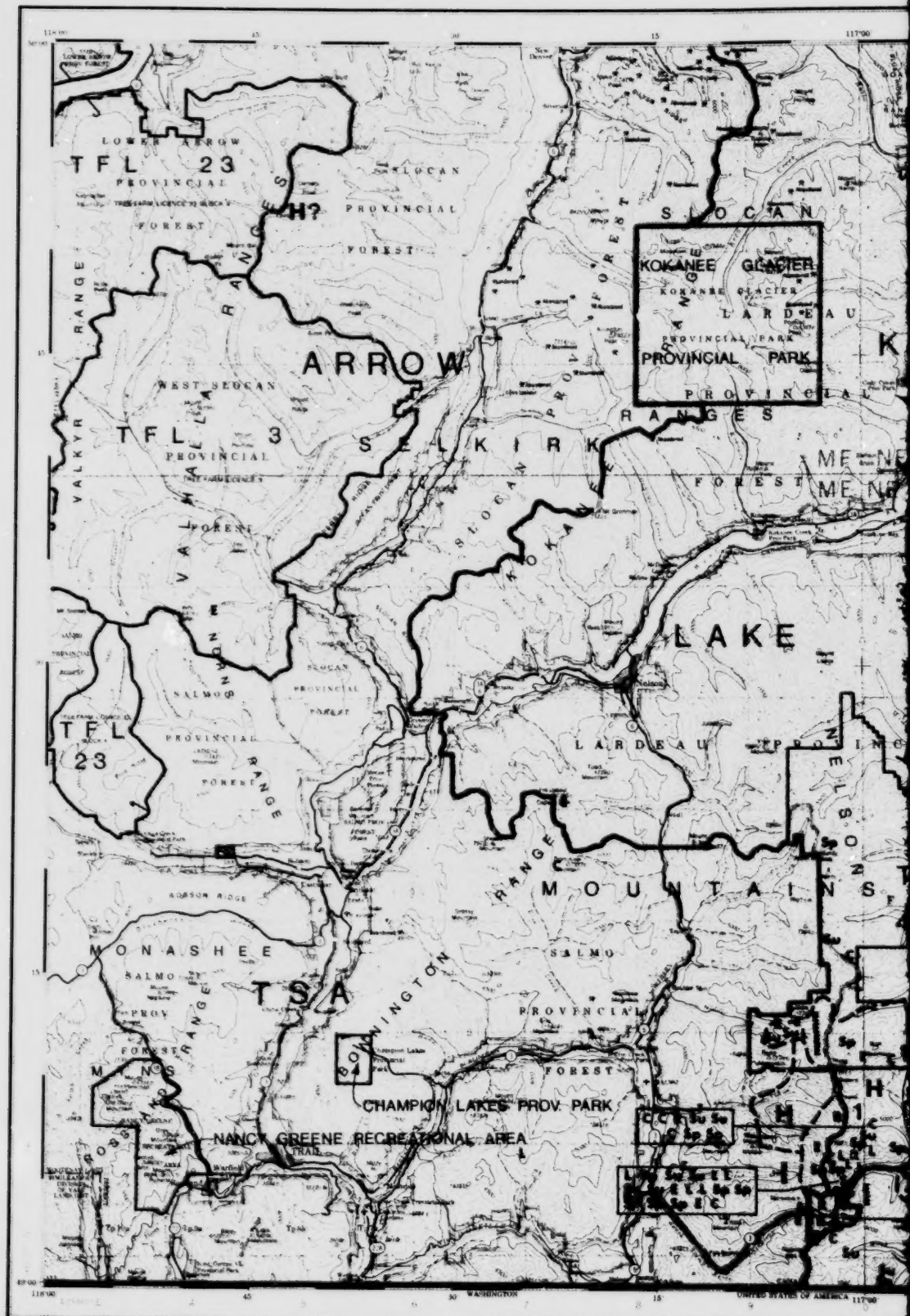
^aSeasons - Dates and durations of open seasons under "males only" or "either sex" (caribou of either sex and any age) regulations. From 1956 to about 1962 in most areas, males under 1 year of age were not open to hunting under the males only designation.

The letter "N" indicates no open season.

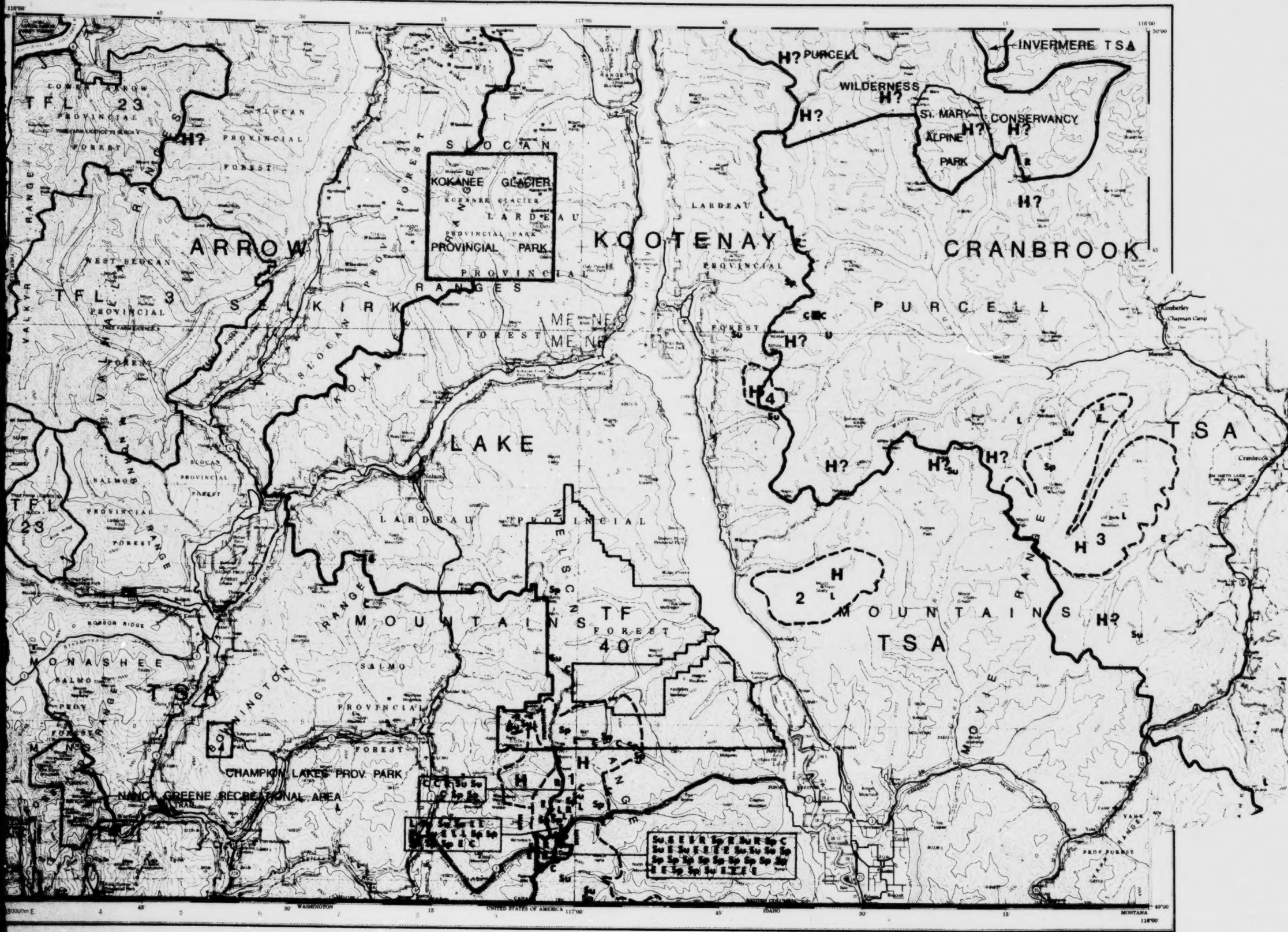
^bGMU - Game Management Unit (see Appendix 2, Vol. 1))

MAPS

Note: In a few cases, the boundaries of caribou ranges were enlarged after the Mark IV analysis (Vol. 1, Section 2.1.1) was completed. In those instances, both sets of boundaries are shown, and the innermost lines refer to the area used for Mark IV analysis. Because the areas for Mark IV analysis were defined by a grid system, their boundaries do not correspond exactly to the boundaries shown on the Caribou range maps.



NELSON



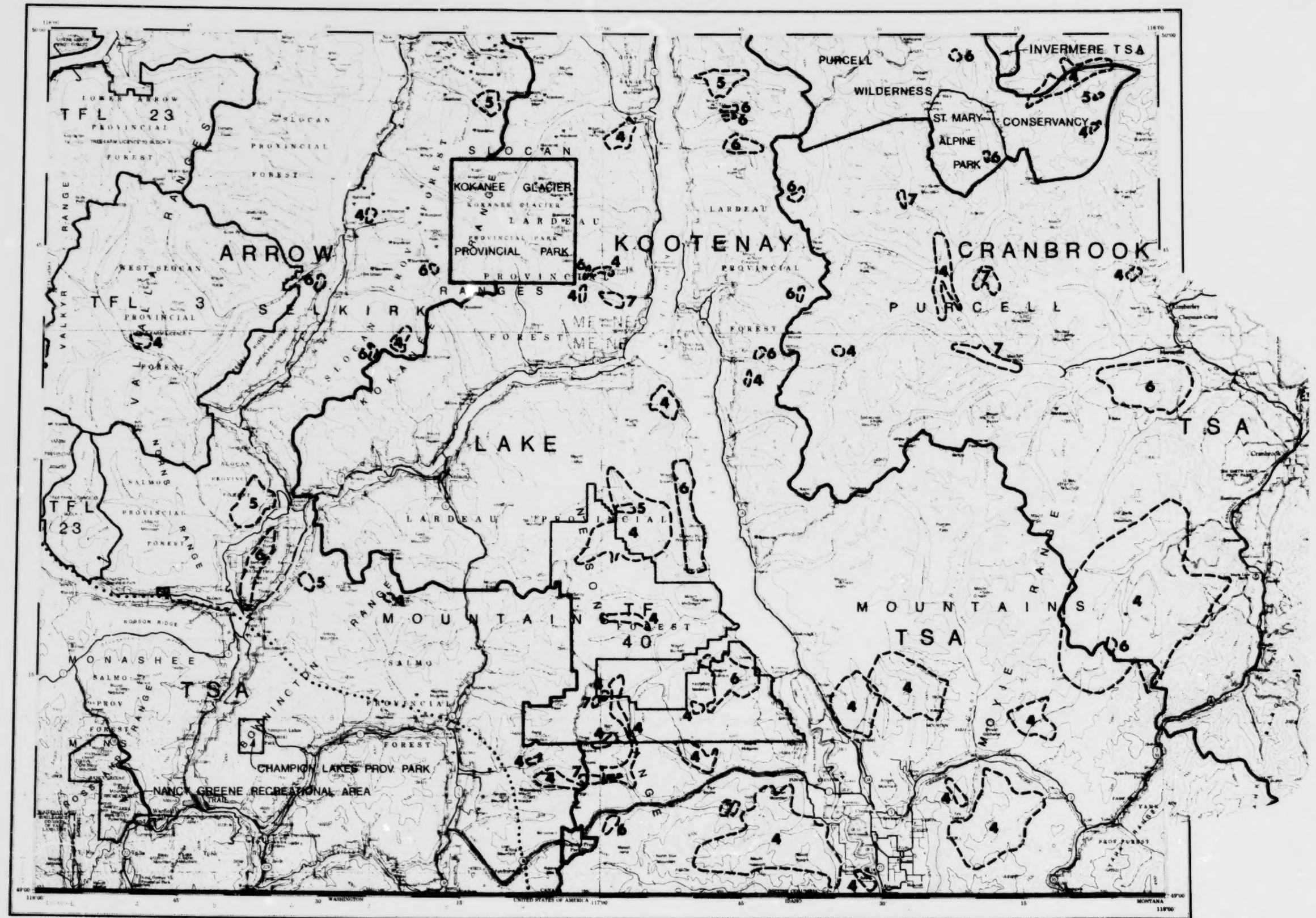
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CARIBOU RANGES

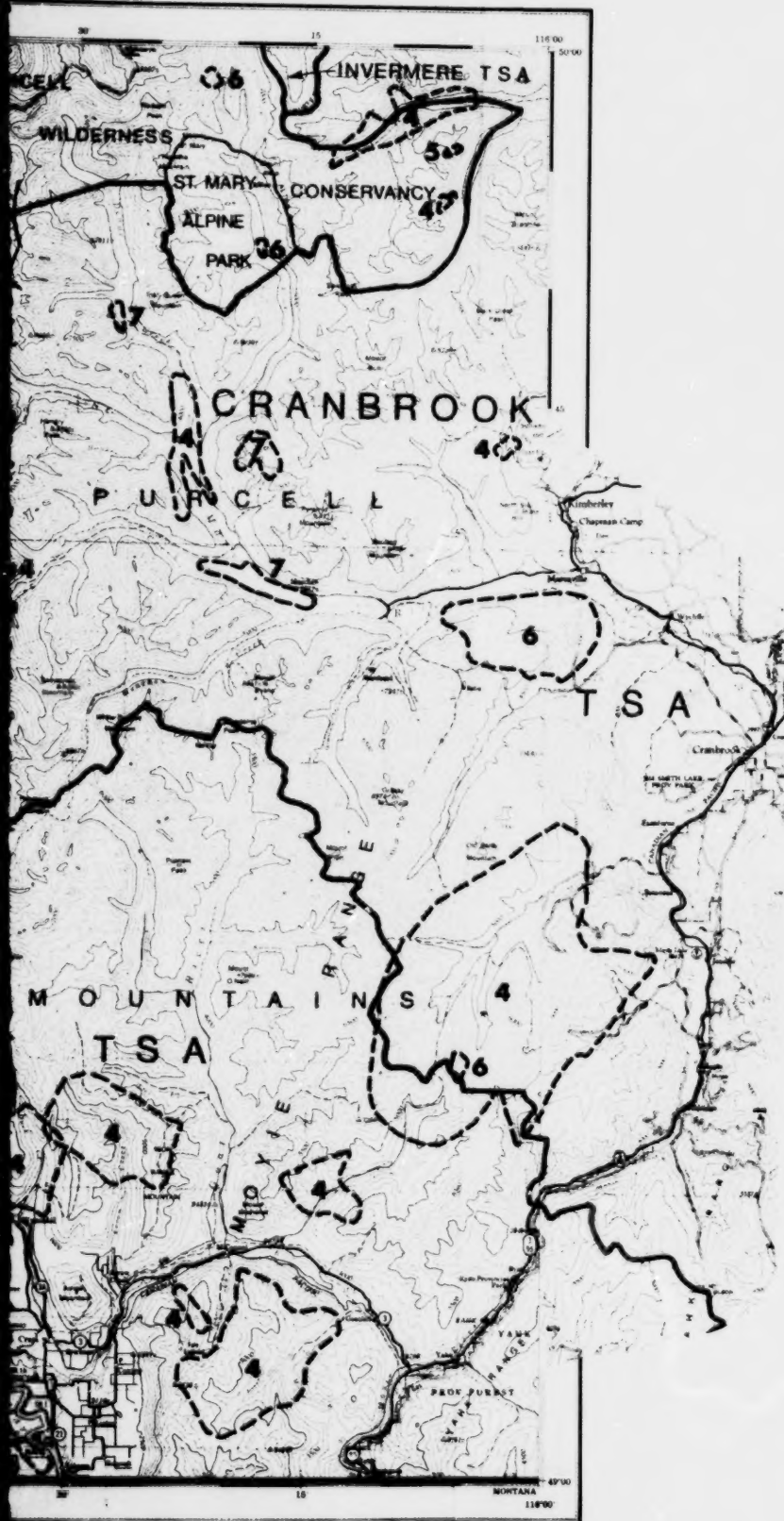
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- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range (May Include Summer Range)
- Low Elevation Winter Range (May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

C	May 21 - June 10	Calving
Su	June 11 - Sept. 20	Summer
R	Sept. 21 - Oct. 20	Rut
E	Oct. 21 - Jan. 15	Early Winter
L	Jan. 16 - Mar. 31	Late Winter
Sp	Apr. 1 - May 20	Spring
U		Unspecified



NELSON

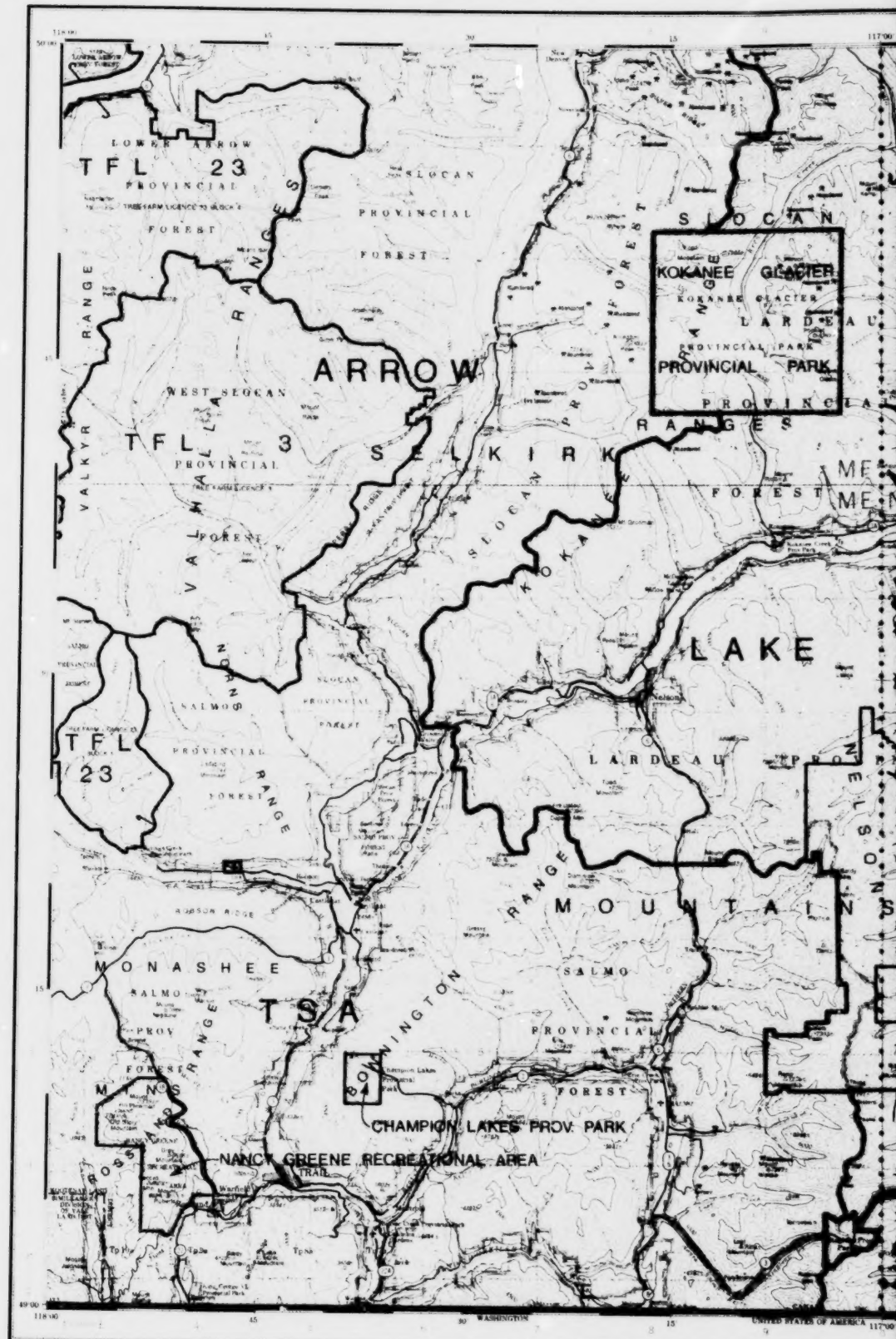


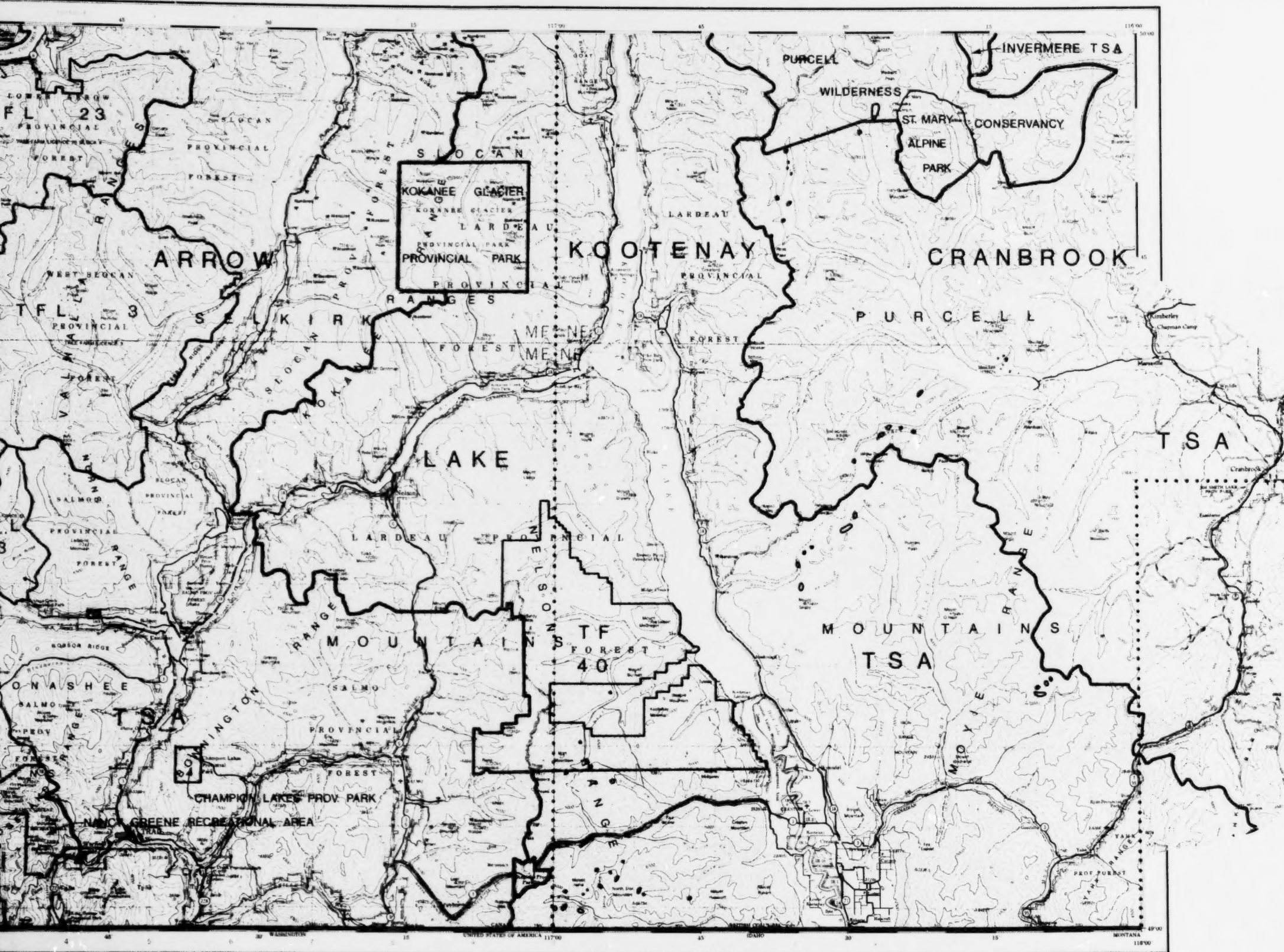
LEGEND

FIRE HISTORY

4	1940-49
5	1950-59
6	1960-69
7	1970-79
8	1980-81
.....	Limit of Mapping

WOODLAND CARIBOU — HABITAT
MAPSHEET 1b 82 F





LEGEND

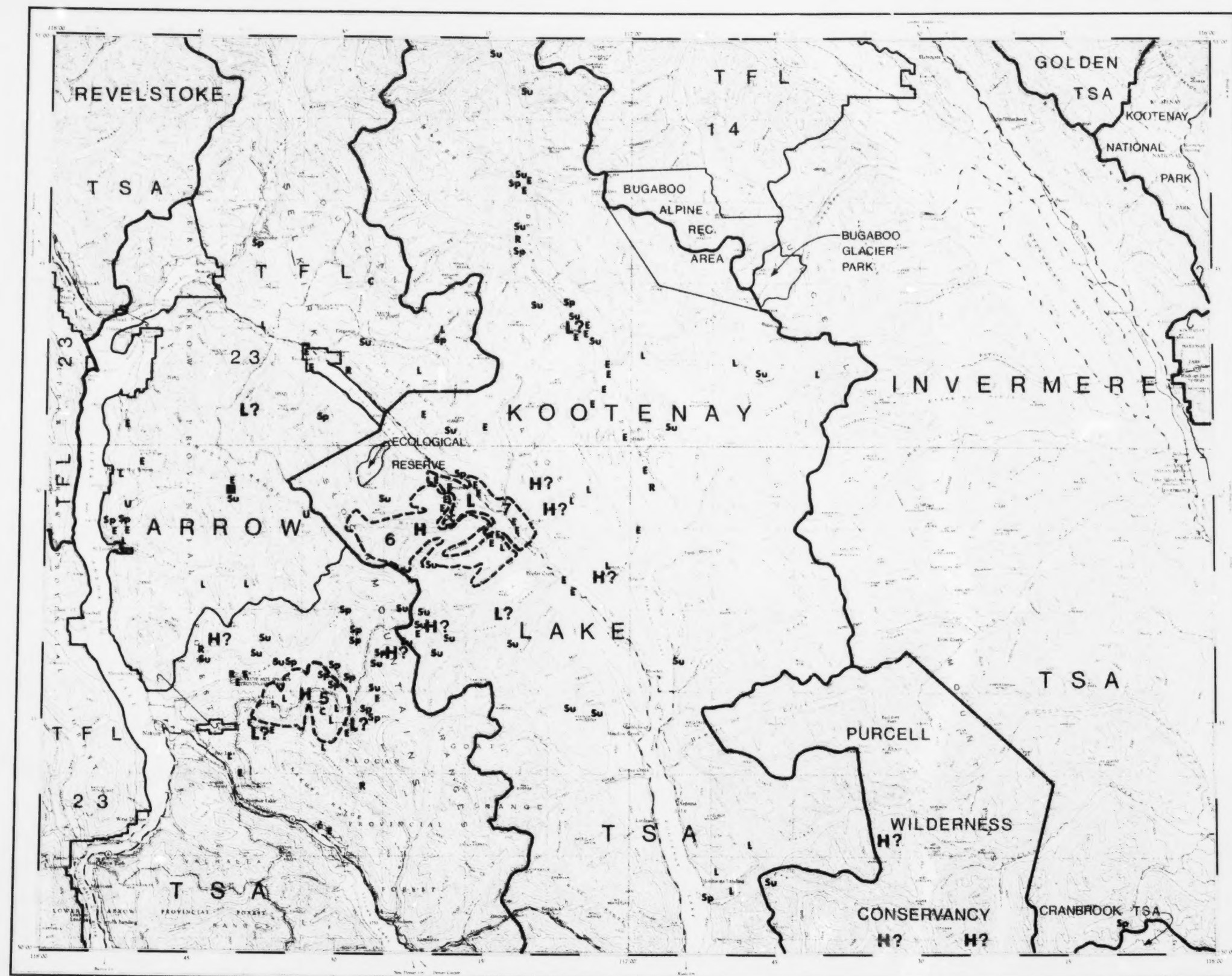
INSECT ATTACK

- Spruce Bark Beetle
- Mountain Pine Beetle
- Limit of Mapping

Source: 1982 Mapping Compiled By Nelson Regional Office, M.O.F. (incomplete)

NELSON

WOODLAND CARIBOU — HABITAT
MAPSHEET 1c 82 F



LEGEND

CARIBOU RANGES

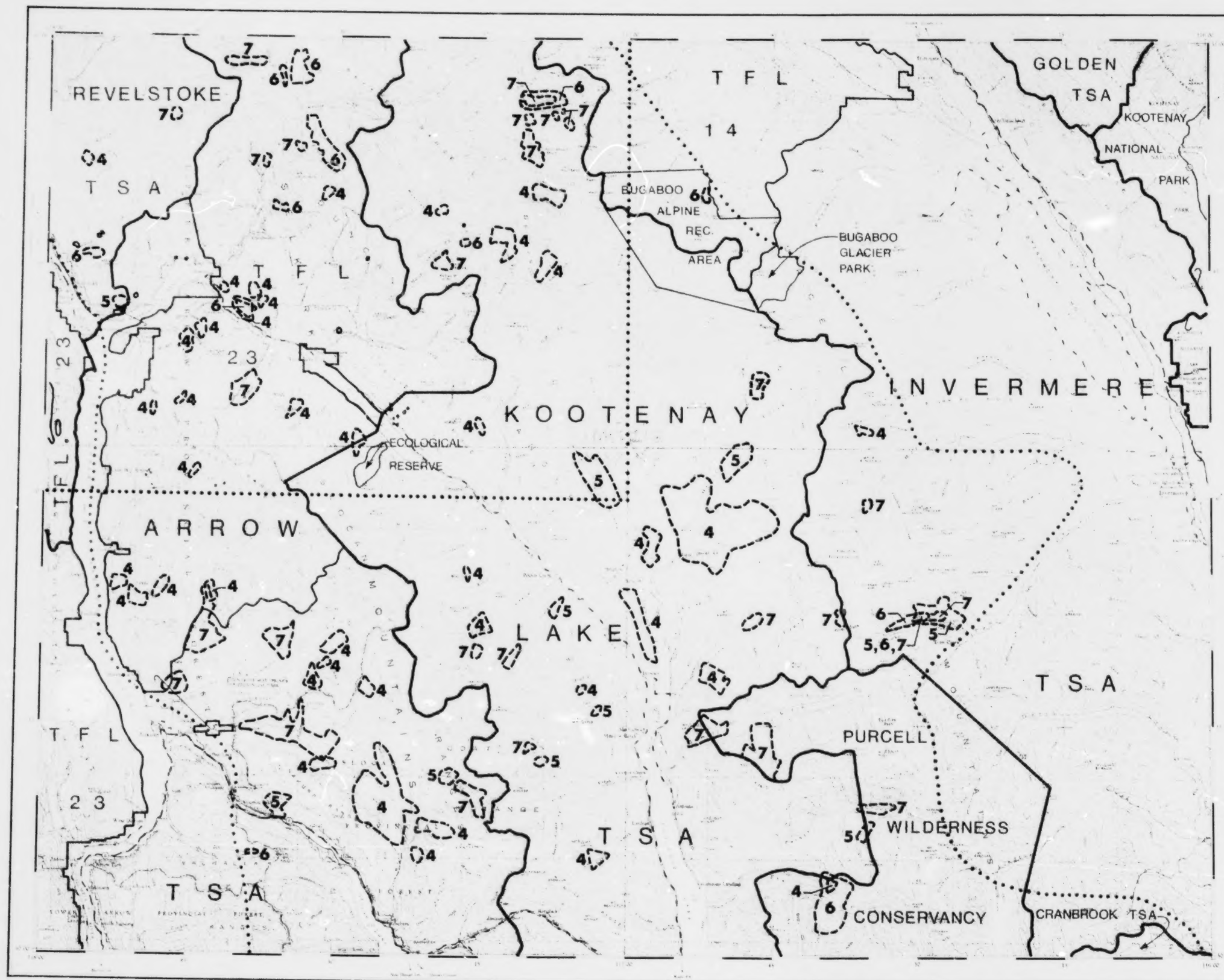
- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range (May Include Summer Range)
- Low Elevation Winter Range (May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

- | | | |
|----|--------------------|--------------|
| C | May 21 - June 10 | Calving |
| Su | June 11 - Sept. 20 | Summer |
| R | Sept. 21 - Oct. 20 | Rut |
| E | Oct. 21 - Jan. 15 | Early Winter |
| L | Jan. 16 - Mar. 31 | Late Winter |
| Sp | Apr. 1 - May 20 | Spring |
| U | | Unspecified |

LARDEAU

WOODLAND CARIBOU — HABITAT
MAPSHEET 2a 82 K



LEGEND

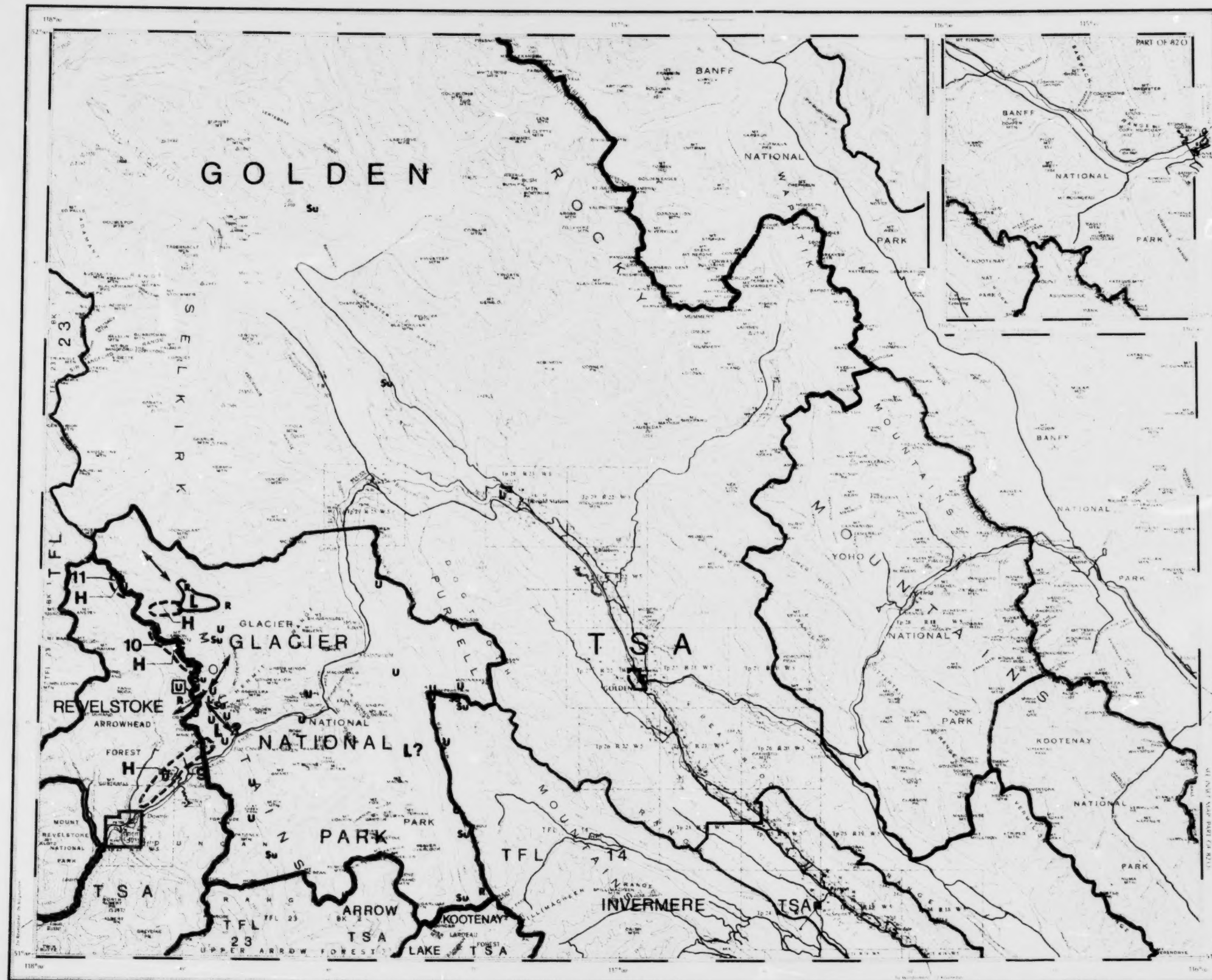
FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81
- Limit of Mapping

INSECT ATTACK

- ~~~~~ Spruce Bark Beetle
- ~~~~~ Mountain Pine Beetle
- Limit of Mapping

Source: 1982 Mapping Compiled By Nelson Regional Office
M.O.F. (incomplete)



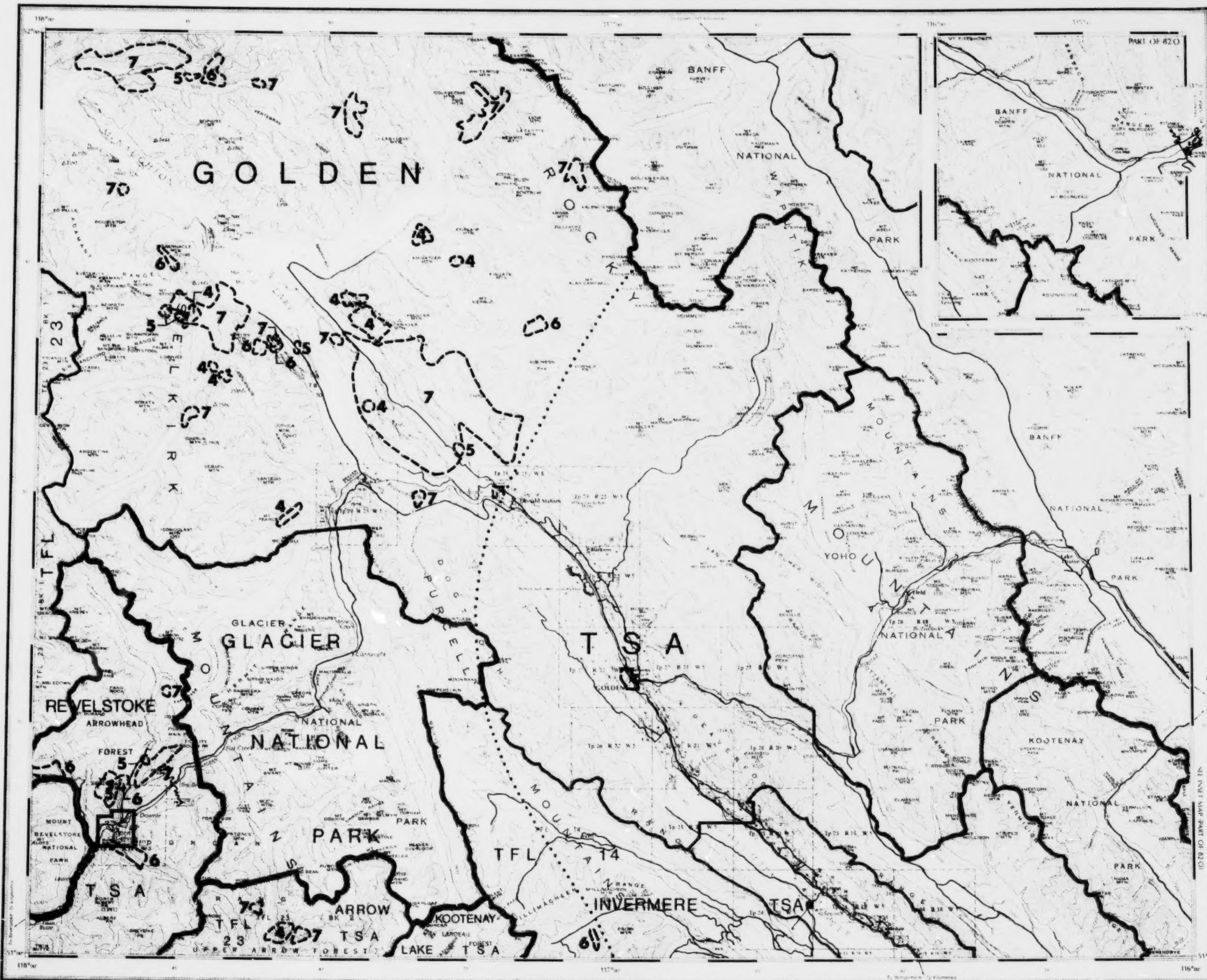
LEGEND

CARIBOU RANGES

- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

- | | | |
|----|--------------------|--------------|
| C | May 21 - June 10 | Calving |
| Su | June 11 - Sept. 20 | Summer |
| R | Sept. 21 - Oct. 20 | Rut |
| E | Oct. 21 - Jan. 15 | Early Winter |
| L | Jan. 16 - Mar. 31 | Late Winter |
| Sp | Apr. 1 - May 20 | Spring |
| U | | Unspecified |



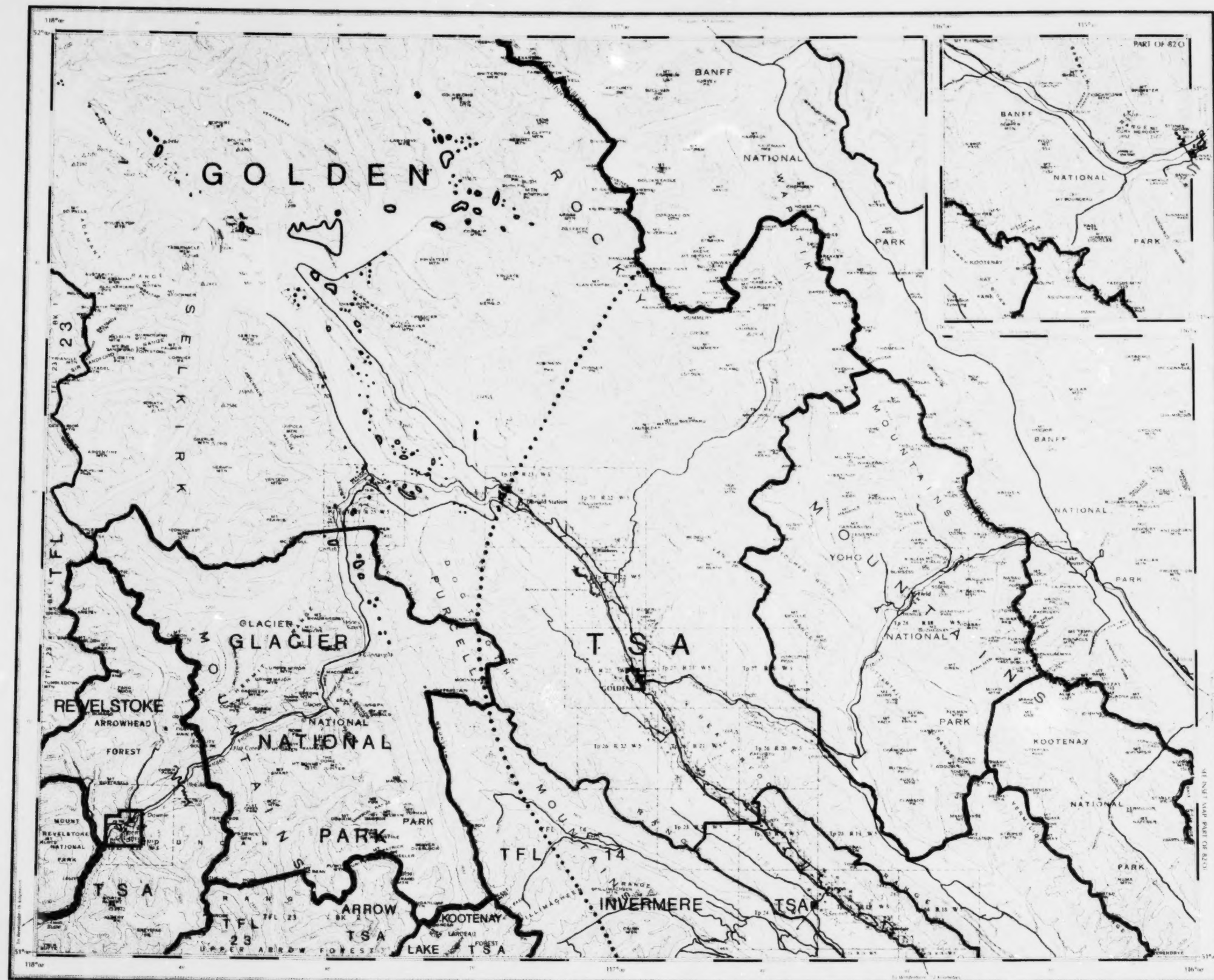
LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81
- Limit of Mapping

GOLDEN

WOODLAND CARIBOU — HABITAT
MAPSHEET 3b 82 N

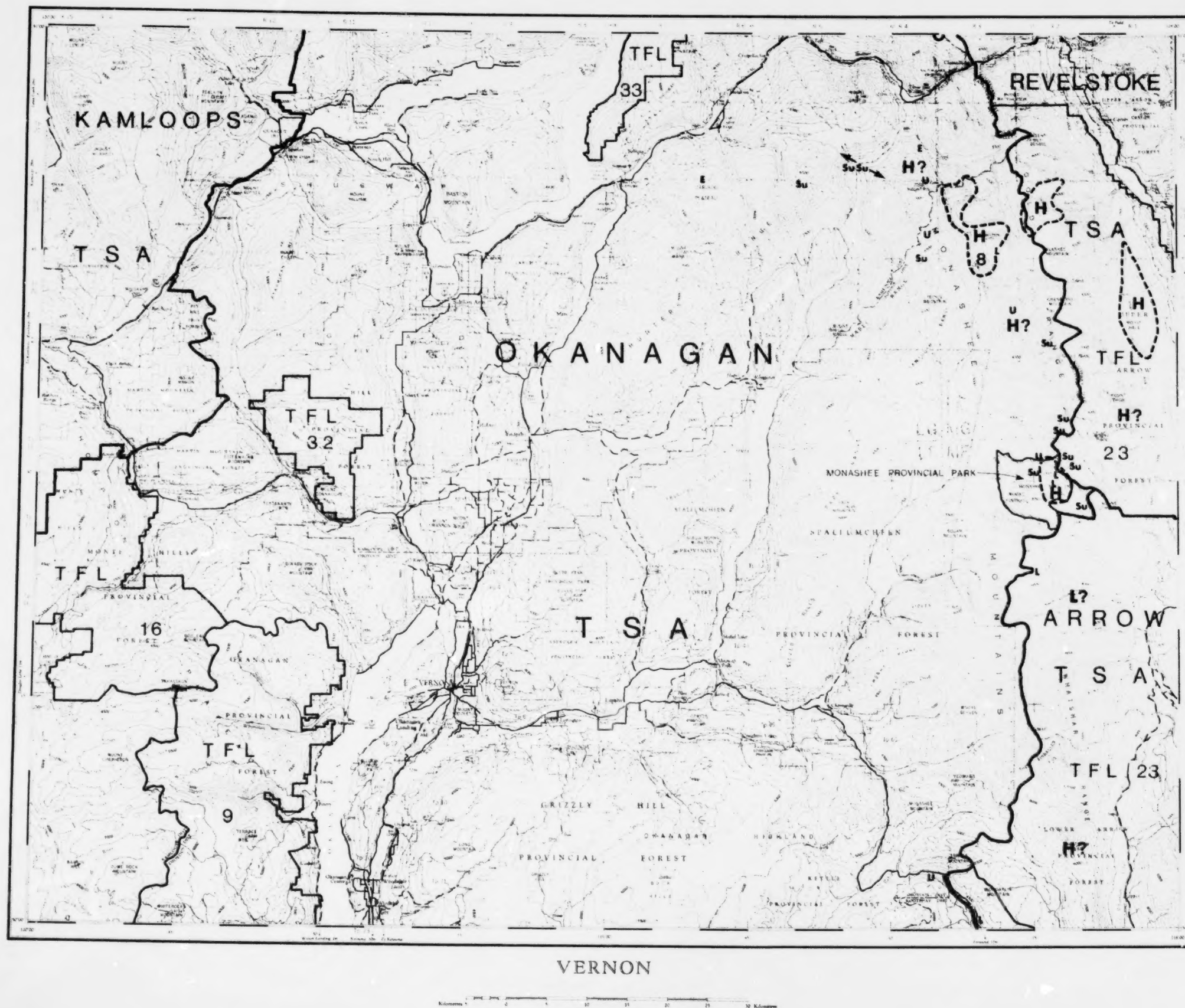


LEGEND

INSECT ATTACK

- Spruce Bark Beetle
- - - Mountain Pine Beetle
- Limit of Mapping

Source 1982 Mapping Compiled By Nelson Regional Office
M.O.F. (incomplete)

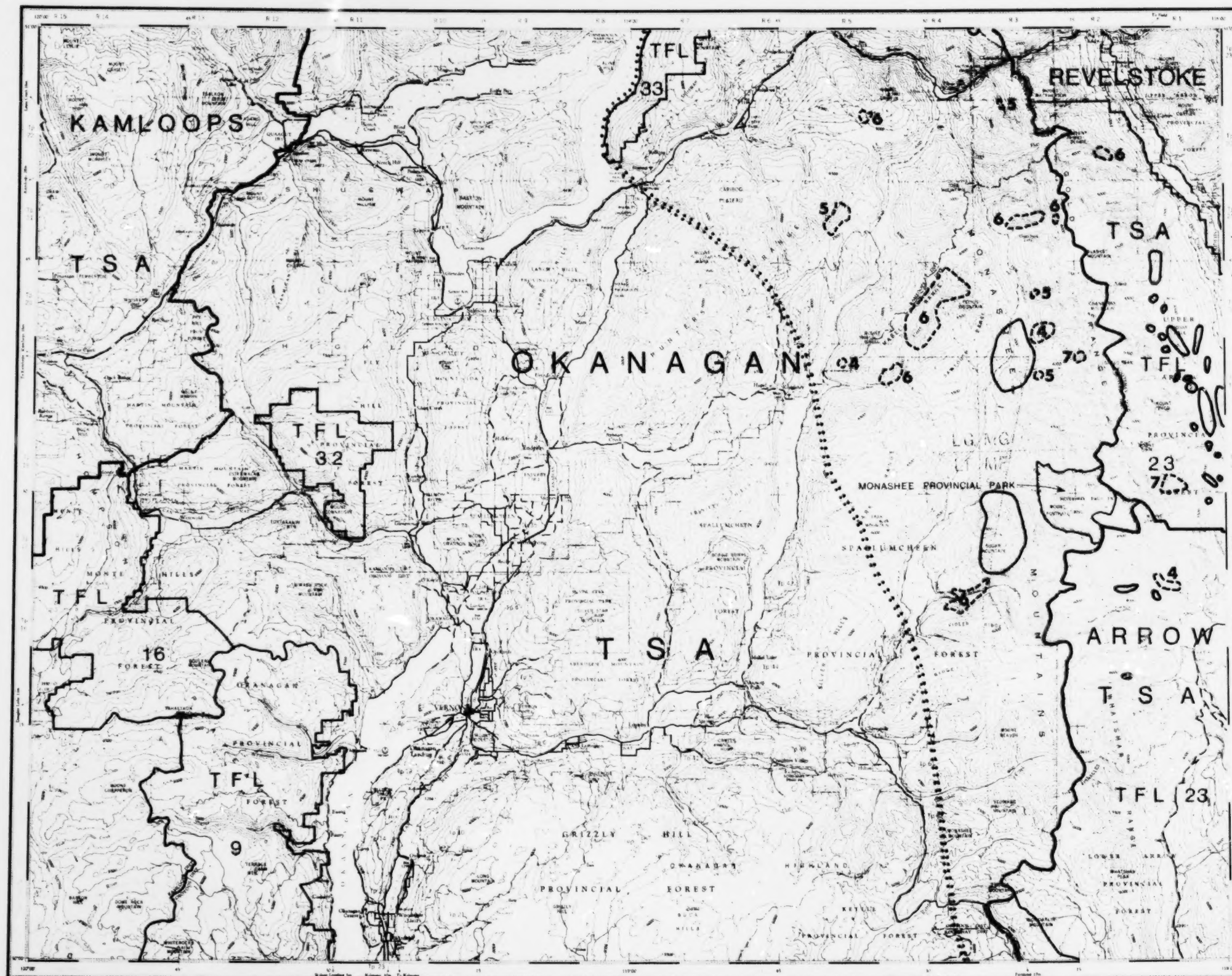


LEGEND

- CARIBOU RANGES**
- Use and Boundaries Known
 - Use Known; Boundaries Uncertain
 - Suspected Ranges
 - High Elevation Winter Range (May Include Summer Range)
 - Low Elevation Winter Range (May Include Fall and Spring Range)
 - Movement Routes
 - Mineral Lick
 - Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

C	May 21 - June 10	Calving
Su	June 11 - Sept. 20	Summer
R	Sept. 21 - Oct. 20	Rut
E	Oct. 21 - Jan. 15	Early Winter
L	Jan. 16 - Mar. 31	Late Winter
Sp	Apr. 1 - May 20	Spring
U		Unspecified



LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81
- Limit of Mapping

INSECT ATTACK

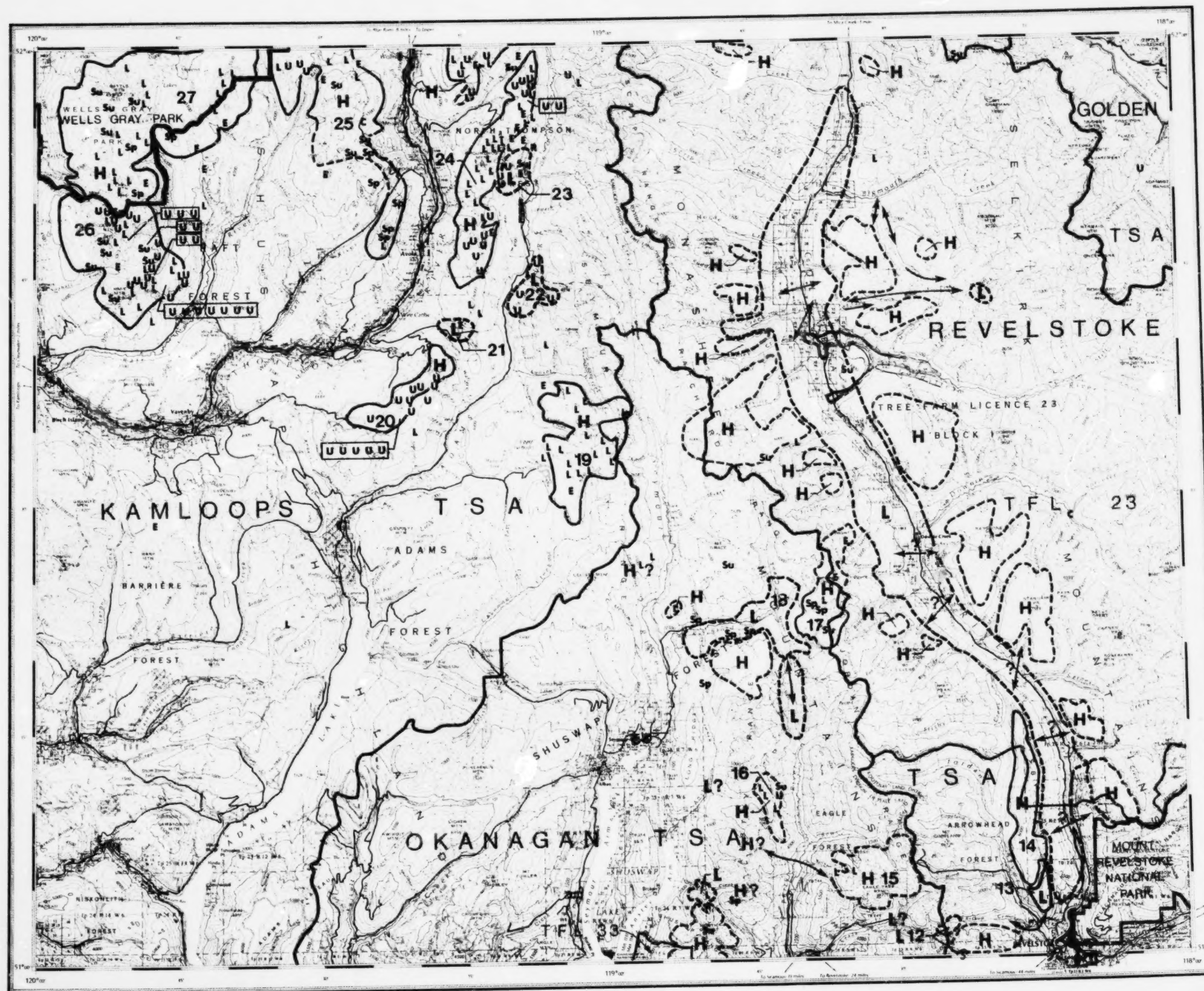
- Spruce Bark Beetle
- Mountain Pine Beetle
- Limit of Mapping

Sources 1982 Mapping Compiled By Nelson Regional Office,
M.O.F. (incomplete)
R. Edwards M.O.F. Kamloops

VERNON

WOODLAND CARIBOU — HABITAT
MAPSHEET 4b 82 L

Scale 1:50,000



LEGEND

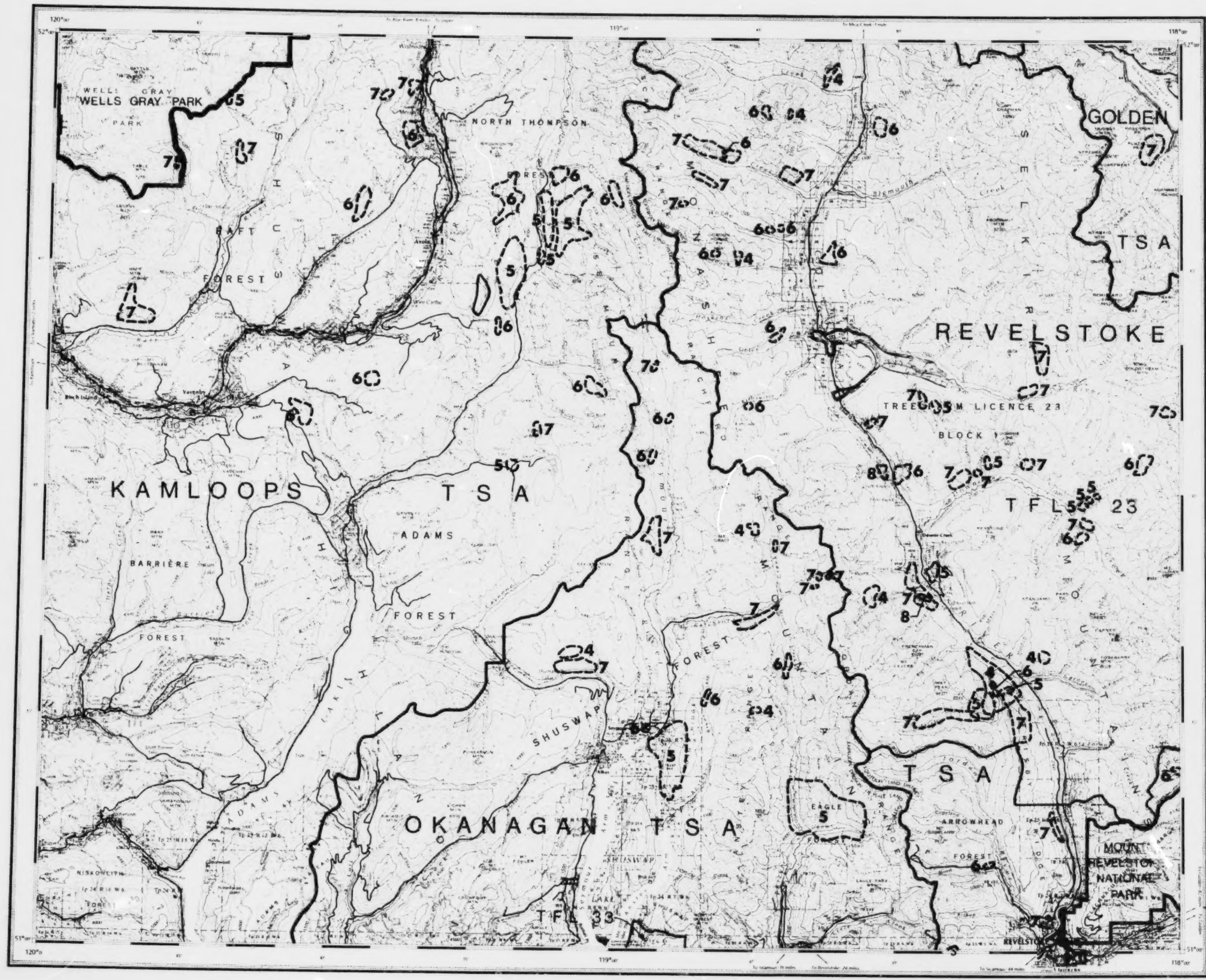
CARIBOU RANGES

- Use and Boundaries Known
- Use Known, Boundaries Uncertain
- Suspected Ranges or Movement Routes
- High Elevation Winter Range (May Include Summer Range)
- Low Elevation Winter Range (May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

- | | | |
|----|--------------------|--------------|
| c | May 21 - June 10 | Calving |
| Su | June 11 - Sept. 20 | Summer |
| R | Sept. 21 - Oct. 20 | Rut |
| E | Oct. 21 - Jan. 15 | Early Winter |
| L | Jan. 16 - Mar. 31 | Late Winter |
| Sp | Apr. 1 - May 20 | Spring |
| U | | Unspecified |

WOODLAND CARIBOU — HABITAT
MAPSHEET 5a 82 M



LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81

INSECT ATTACK

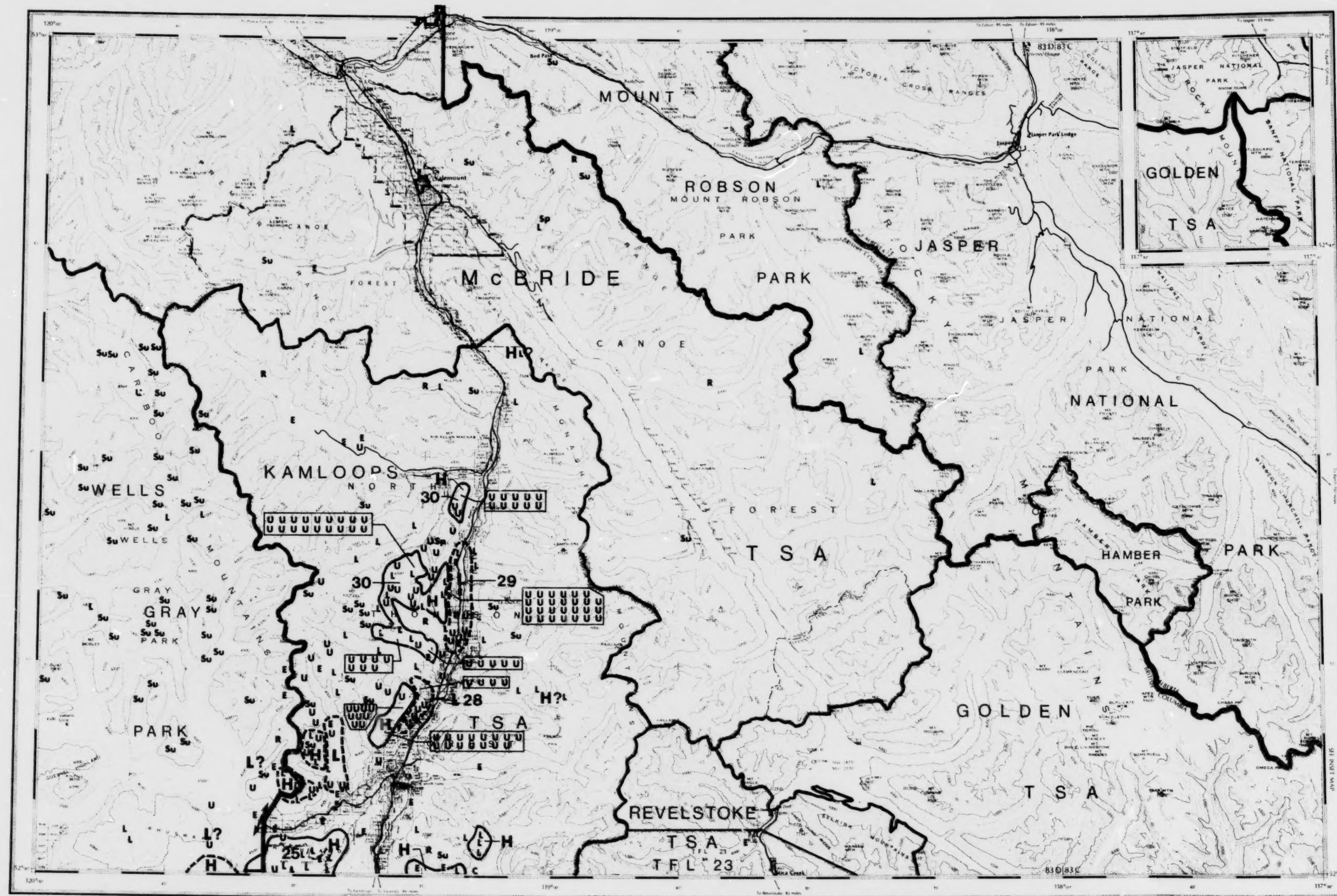
-  Spruce Bark Beetle
-  Mountain Pine Beetle

Source: R. Edwards, M.O.F. Kamloops

SEYMOUR ARM

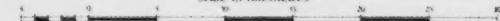
Scale of Kilometres

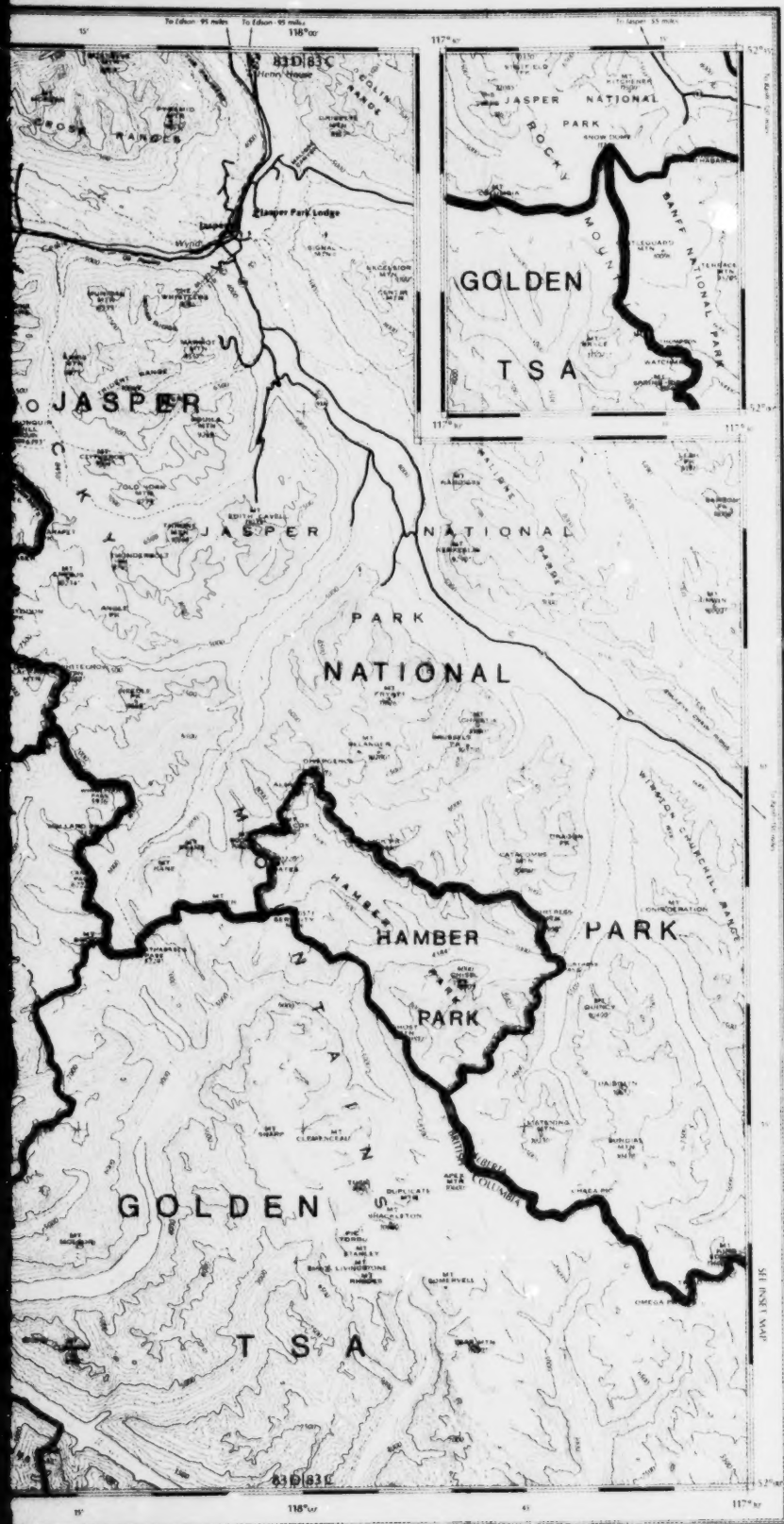
WOODLAND CARIBOU — HABITAT
MAPSHEET 5b 82 M



MCNAUGHTON LAKE

Scale of Kilometres





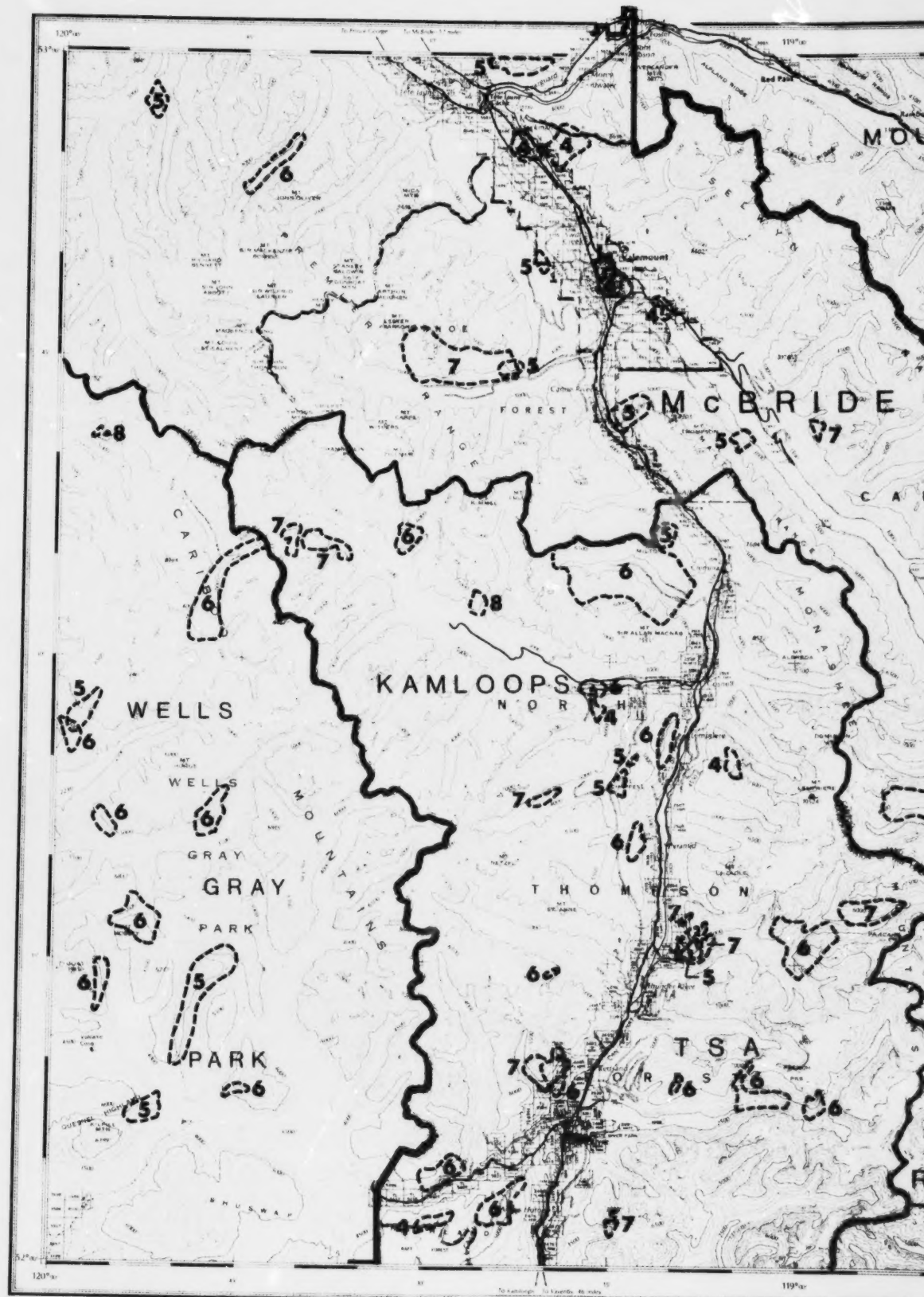
LEGEND

CARIBOU RANGES

- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

- C** May 21 - June 10 Calving
- Su** June 11 - Sept. 20 Summer
- R** Sept. 21 - Oct. 20 Rut
- E** Oct. 21 - Jan. 15 Early Winter
- L** Jan. 16 - Mar. 31 Late Winter
- Sp** Apr. 1 - May 20 Spring
- U** Unspecified

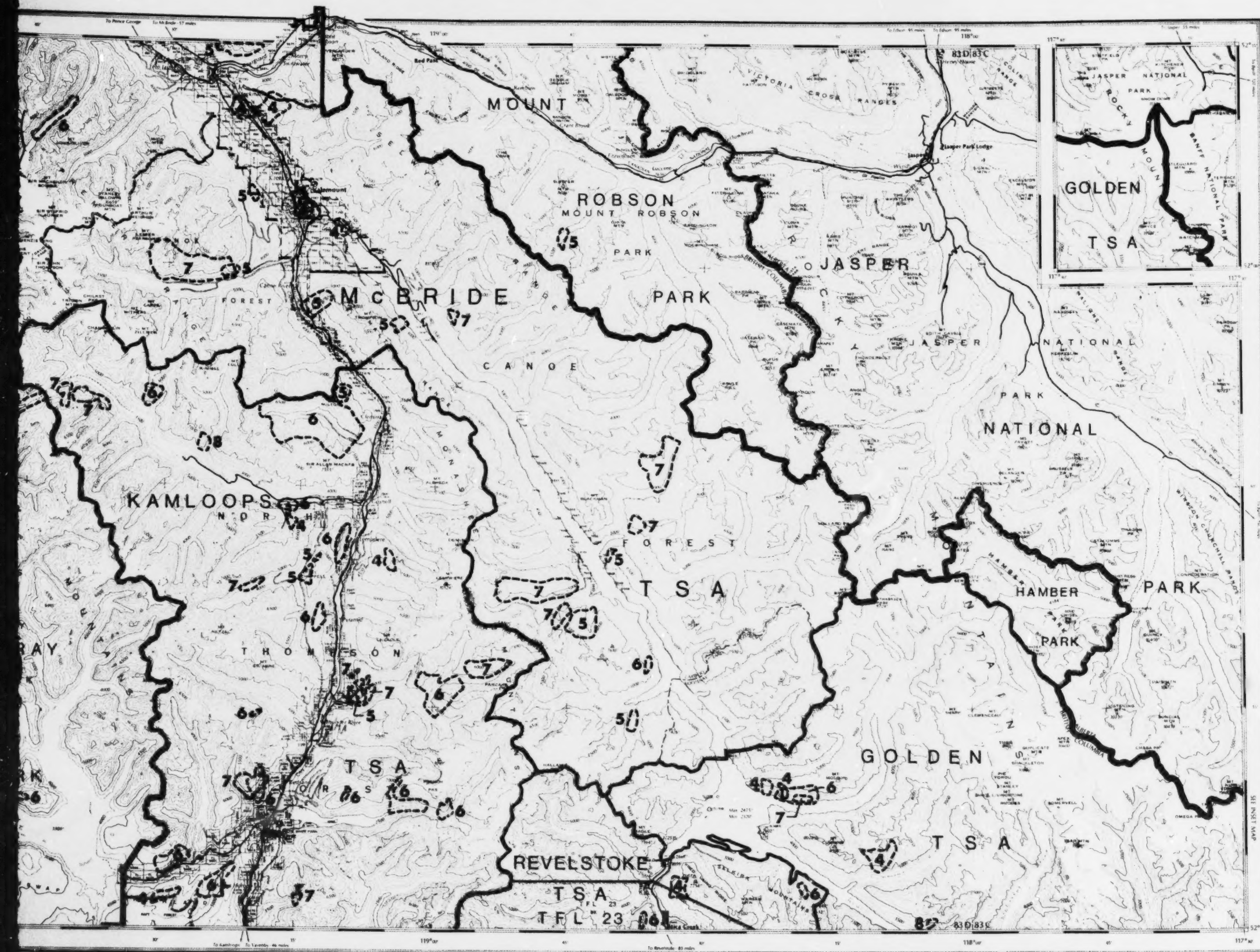


MCNAU

LEGEND

FIRE HISTORY

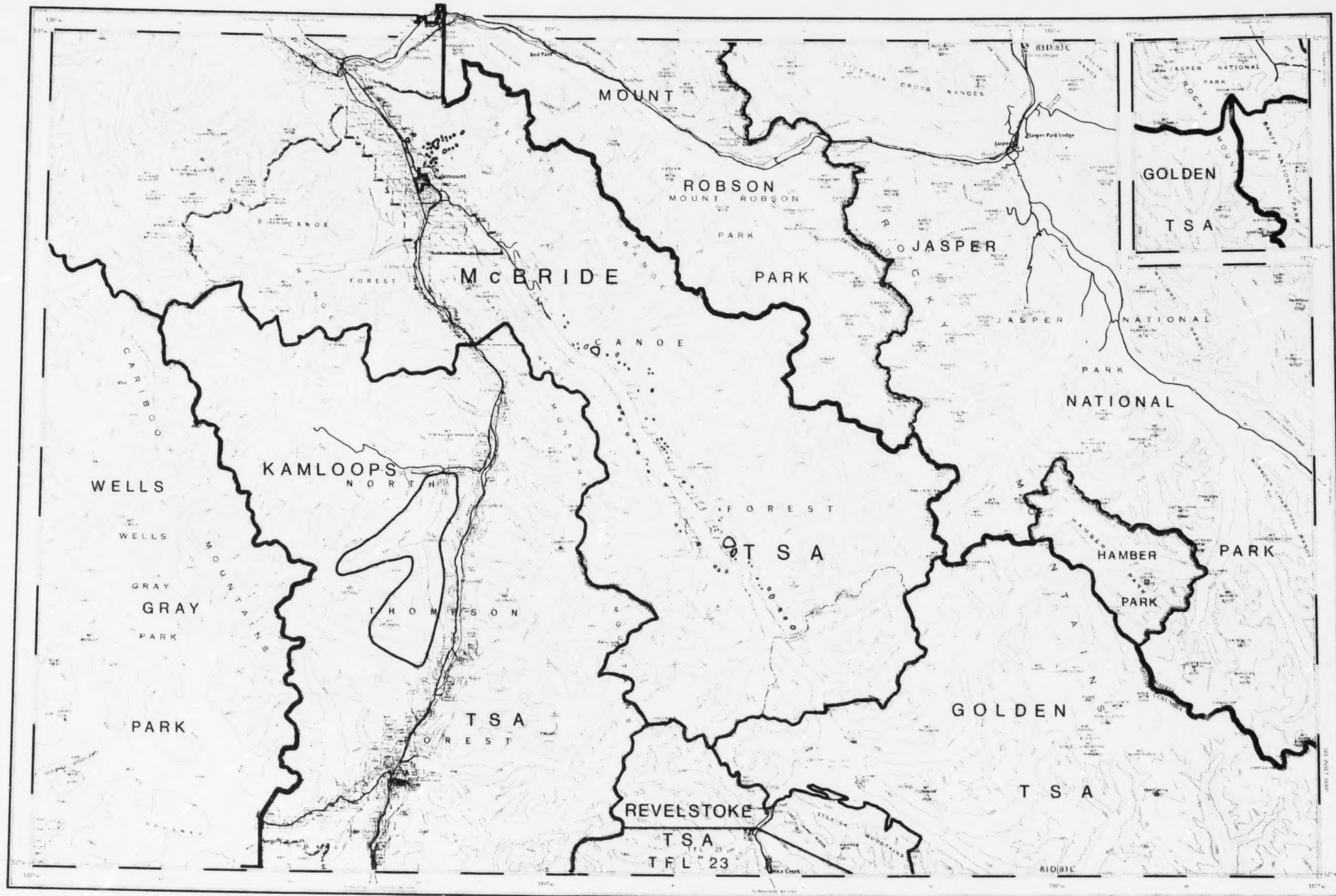
- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81



McNAUGHTON LAKE

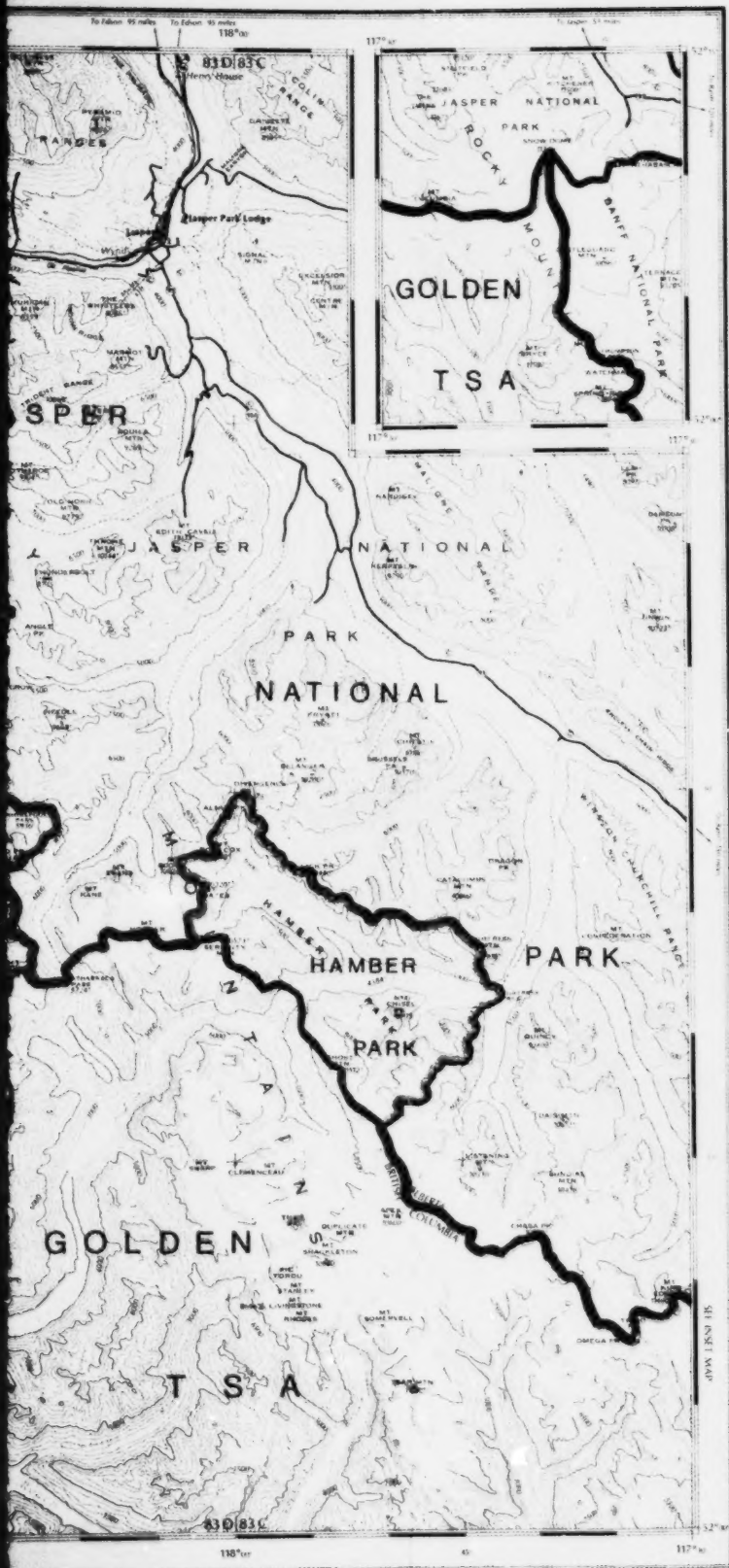
Scale of Kilometres

WOODLAND CARIBOU — HABITAT
MAPSHEET 6b 83 D



McNAUGHTON LAKE

Scale of Kilometres



LEGEND

INSECT ATTACK



Spruce Bark Beetle

Mountain Pine Beetle

Sources: R. Edwards, Pers. Comm.
CFS Mapping Program 1981

WOODLAND CARIBOU — HABITAT
MAPSHEET 6c 83 D



LEGEND

- CARIBOU RANGES**
- Use and Boundaries Known
 - Use Known; Boundaries Uncertain
 - Suspected Ranges or Movement Routes
 - High Elevation Winter Range (May Include Summer Range)
 - Low Elevation Winter Range (May Include Fall and Spring Range)
 - Movement Routes
 - Mineral Lick
 - Reference Number for Mark IV Analysis

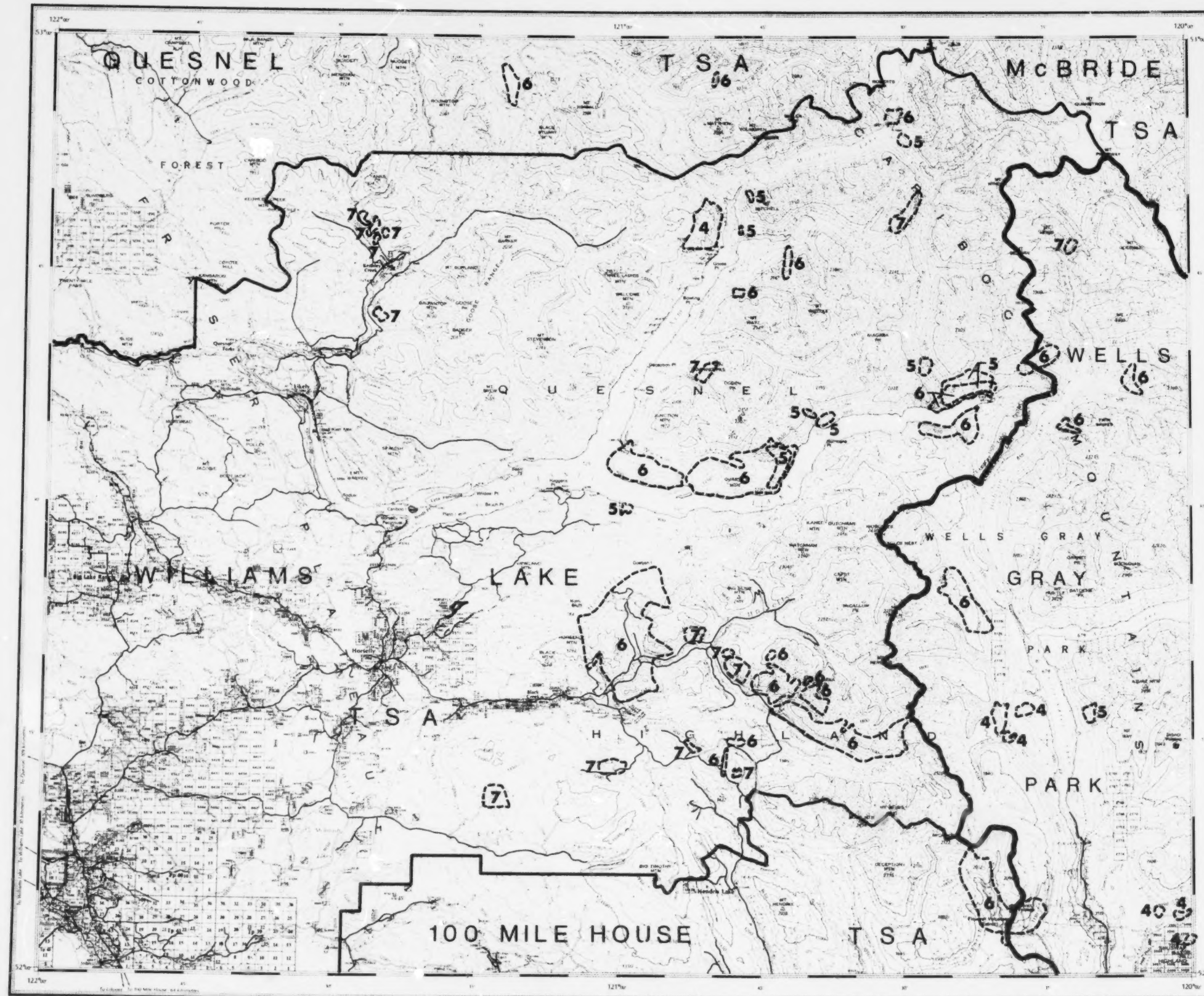
CARIBOU OBSERVATIONS

C	May 21 - June 10	Calving
Su	June 11 - Sept. 20	Summer
R	Sept. 21 - Oct. 20	Rut
E	Oct. 21 - Jan. 15	Early Winter
L	Jan. 16 - Mar. 31	Late Winter
Sp	Apr. 1 - May 20	Spring
U		Unspecified

LEGEND

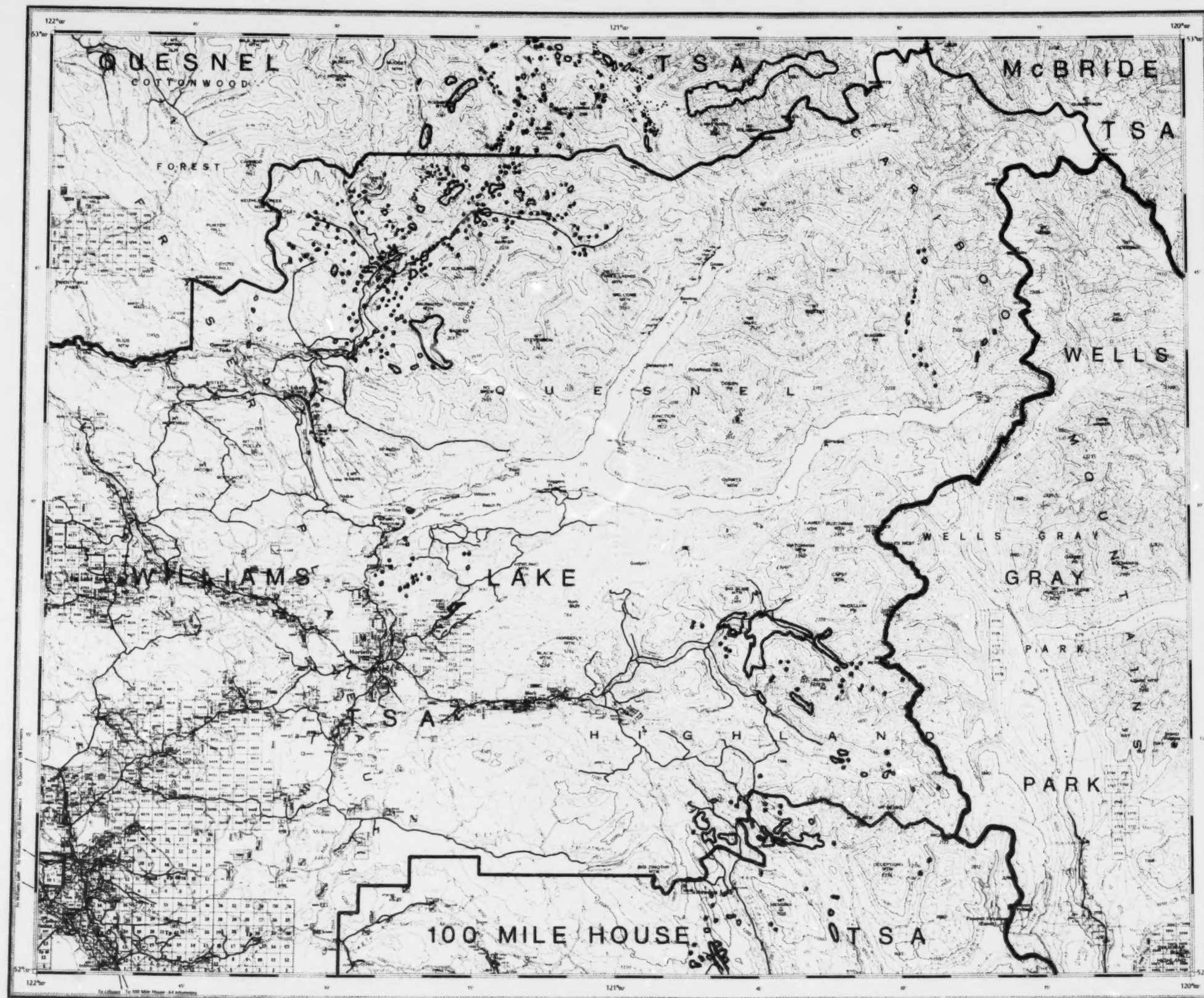
FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81



QUESNEL LAKE

WOODLAND CARIBOU — HABITAT
MAPSHEET 7b 93 A



LEGEND

INSECT ATTACK



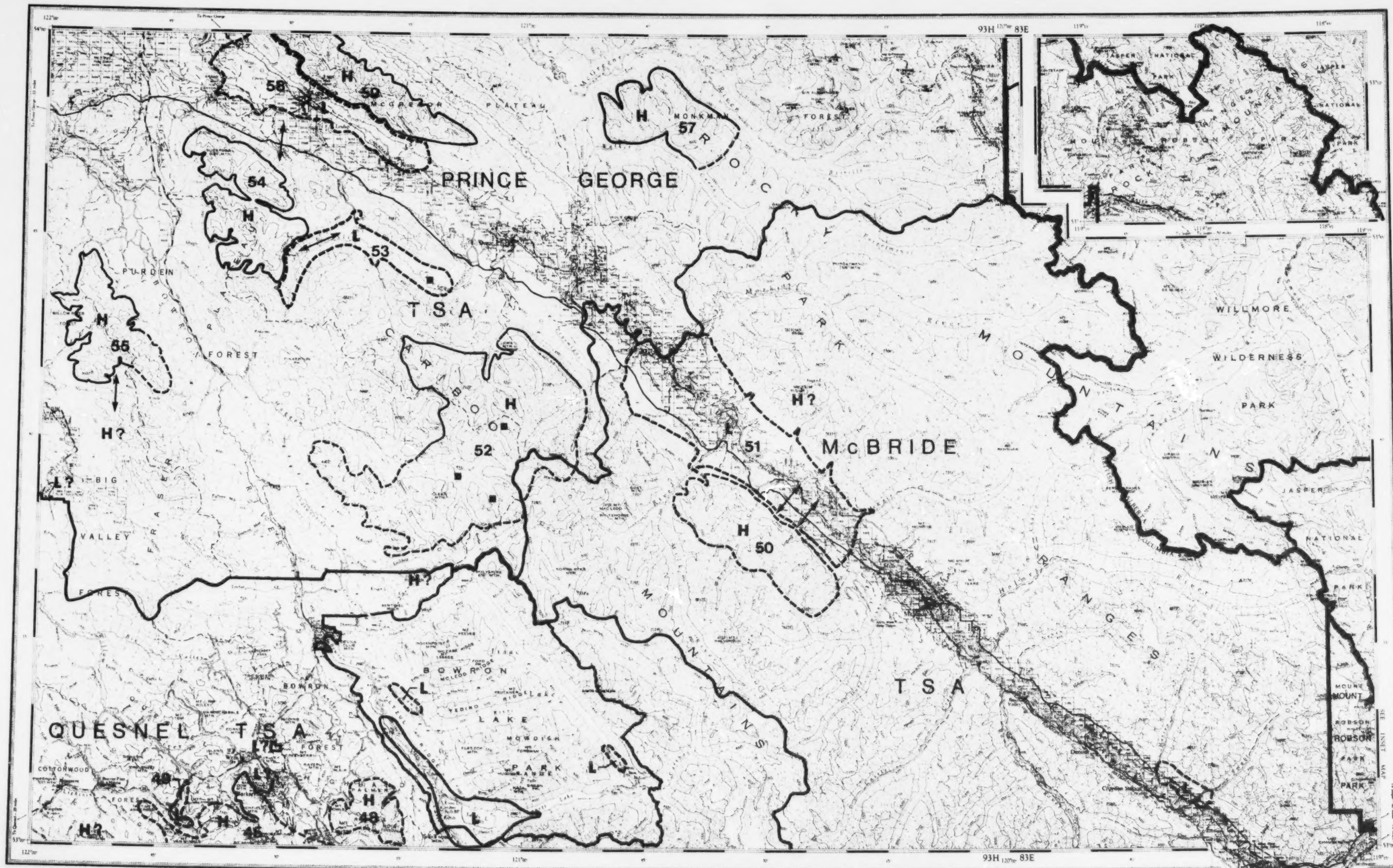
Spruce Bark Beetle

Mountain Pine Beetle

Source: Caribou Forest Region Maps, 1981

QUESNEL LAKE

WOODLAND CARIBOU — HABITAT
MAPSHEET 7c 93 A



McBRIDE

Scale of Kilometres



LEGEND

CARIBOU RANGES

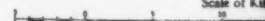
-  Use and Boundaries Known
-  Use Known; Boundaries Uncertain
-  Suspected Ranges
-  High Elevation Winter Range
(May Include Summer Range)
-  Low Elevation Winter Range
(May Include Fall and Spring Range)
-  Movement Routes
-  Mineral Lick
-  Reference Number for Mark IV Analysis

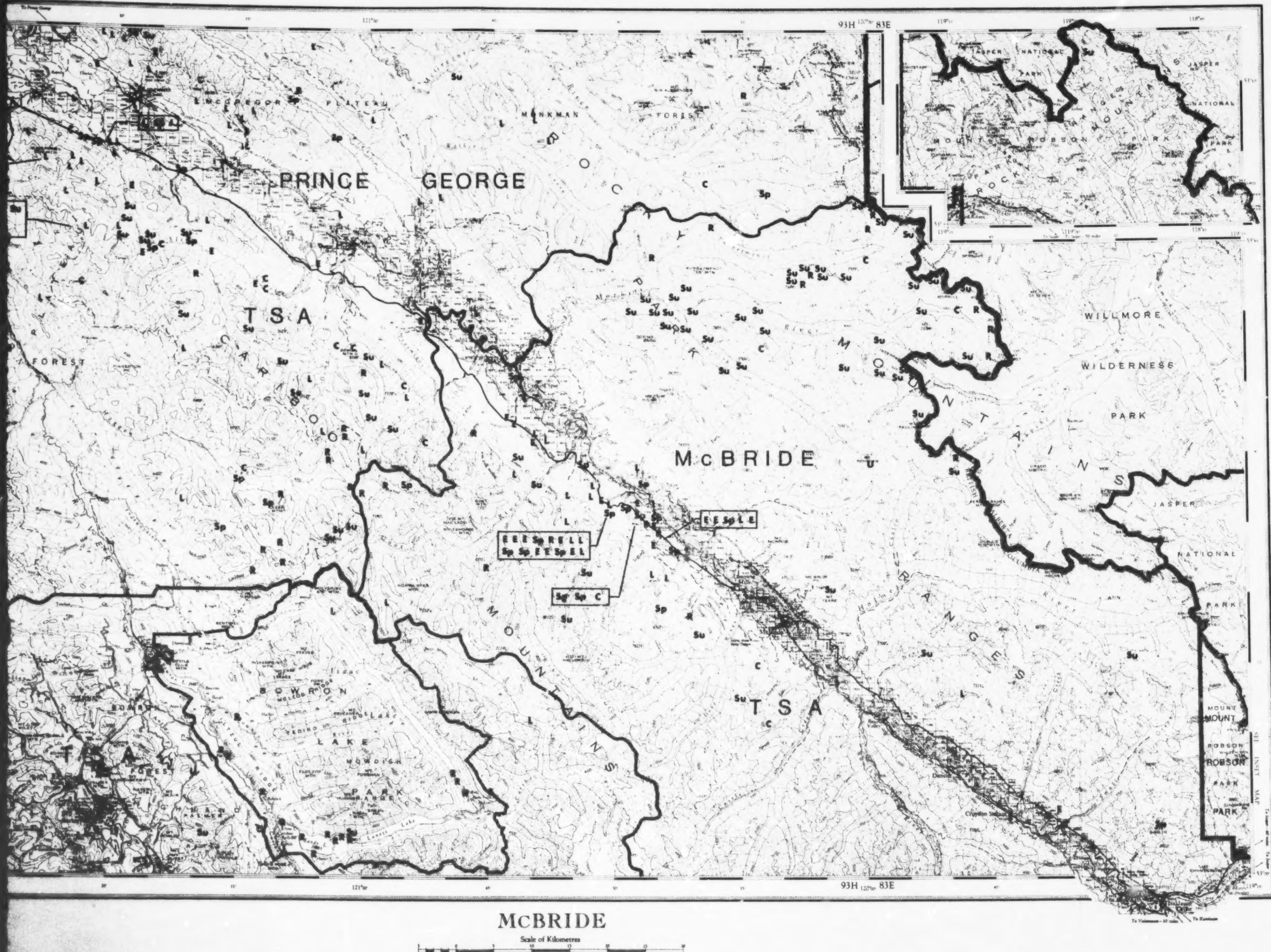
WOODLAND CARIBOU — HABITAT
MAPSHEET 8a 93 H

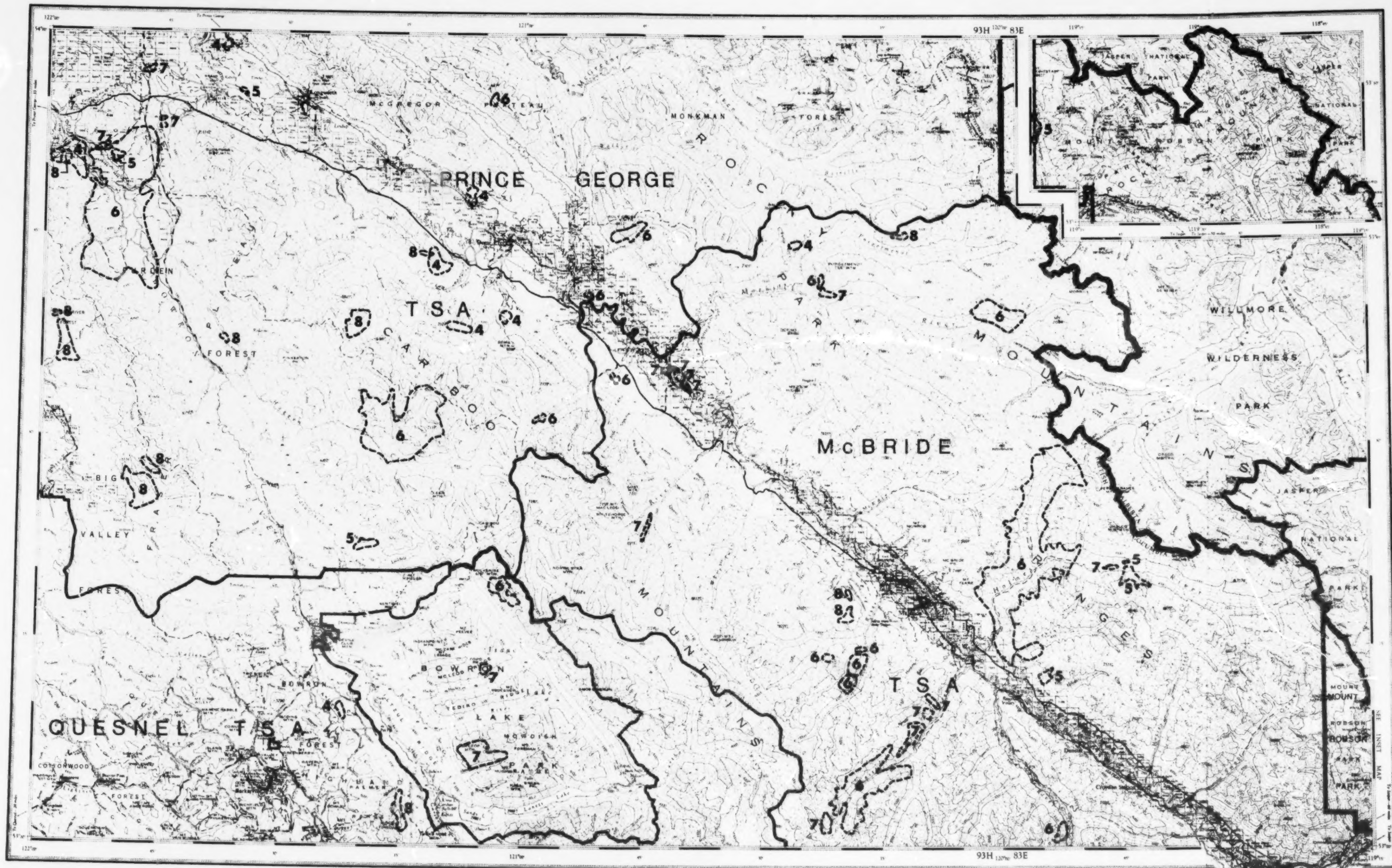


MCB

Scale of Kil

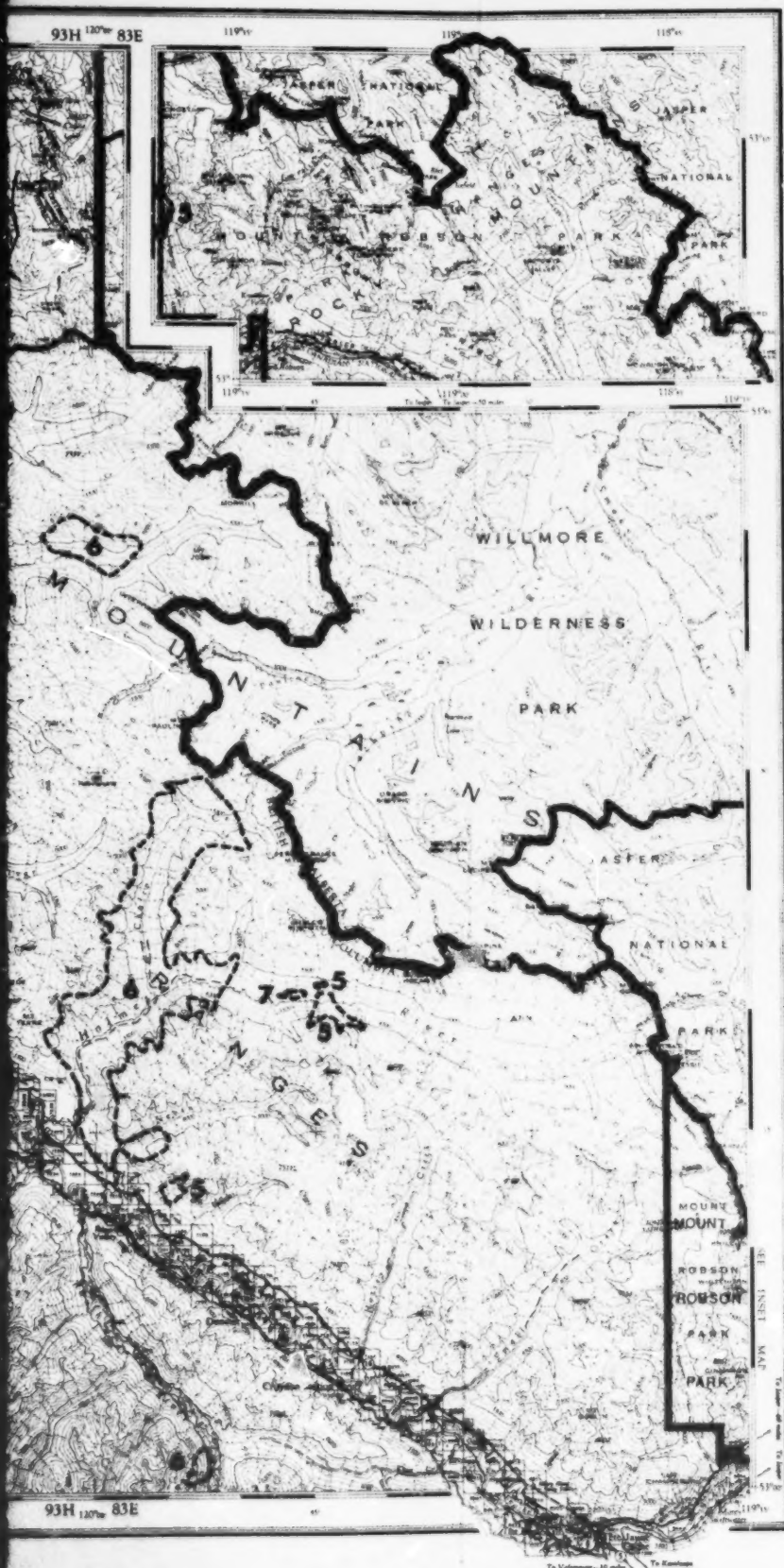






MCBRIDE

Scale of Kilometres

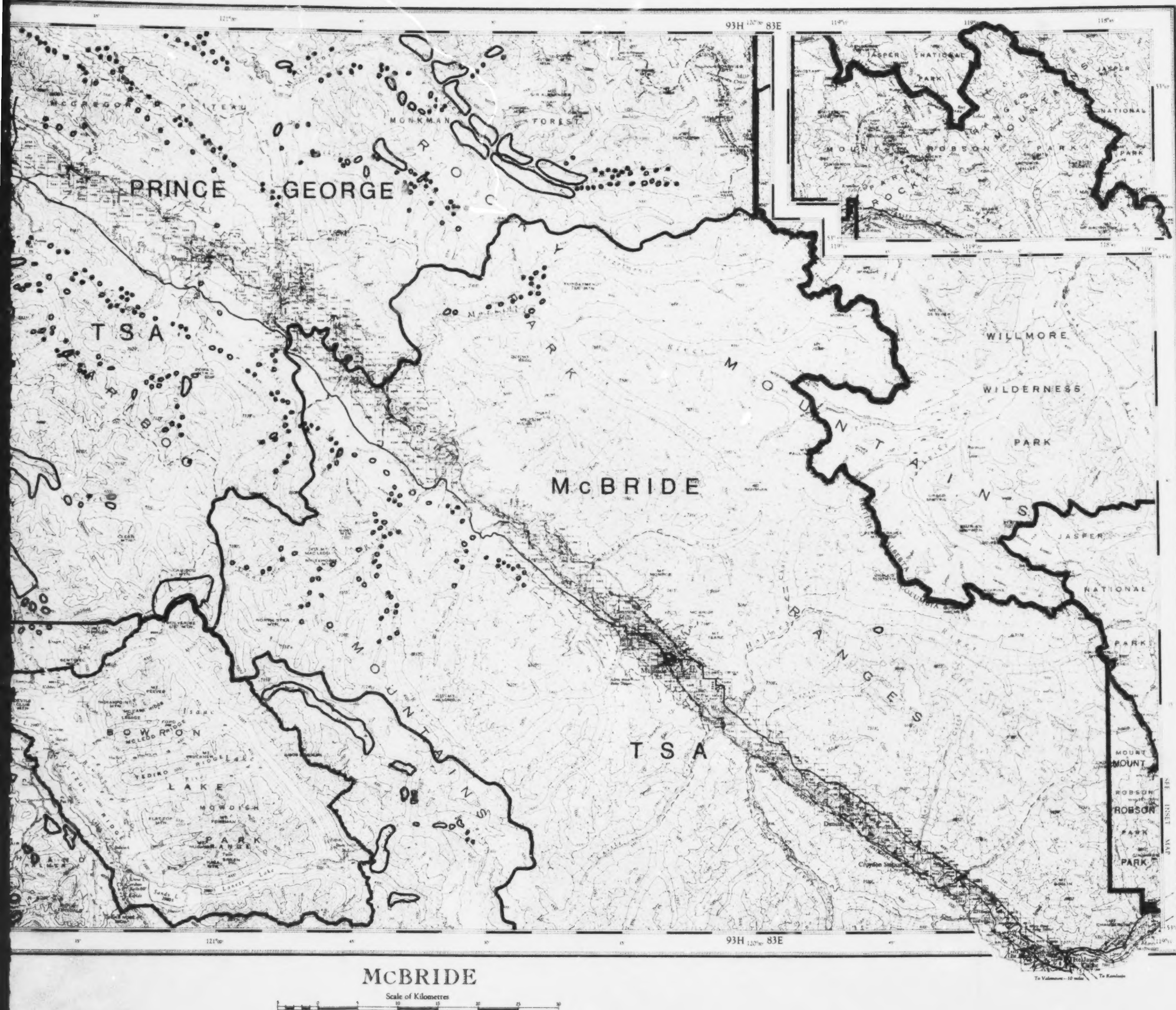


LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81

WOODLAND CARIBOU — HABITAT
MAPSHEET 8c 93 H



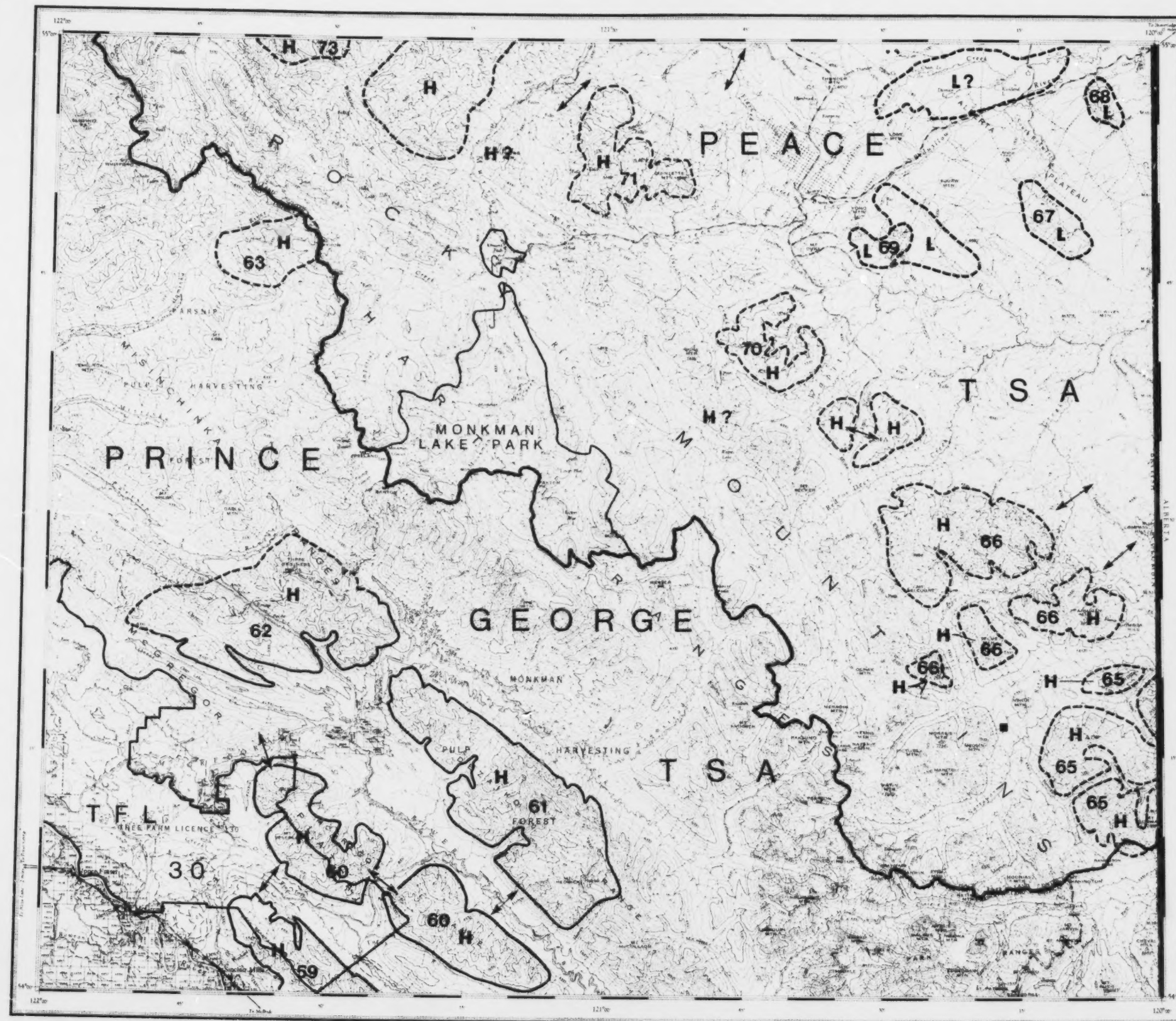
LEGEND

INSECT ATTACK

- Spruce Bark Beetle
- Mountain Pine Beetle
- Limit of Mapping

Sources: CFS Mapping Program 1981
D. Williams, Pers. Comm.
Caribou Forest Region Mapping Program 1981

WOODLAND CARIBOU — HABITAT
MAPSHEET 8d 93 H



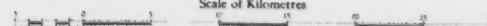
LEGEND

CARIBOU RANGES

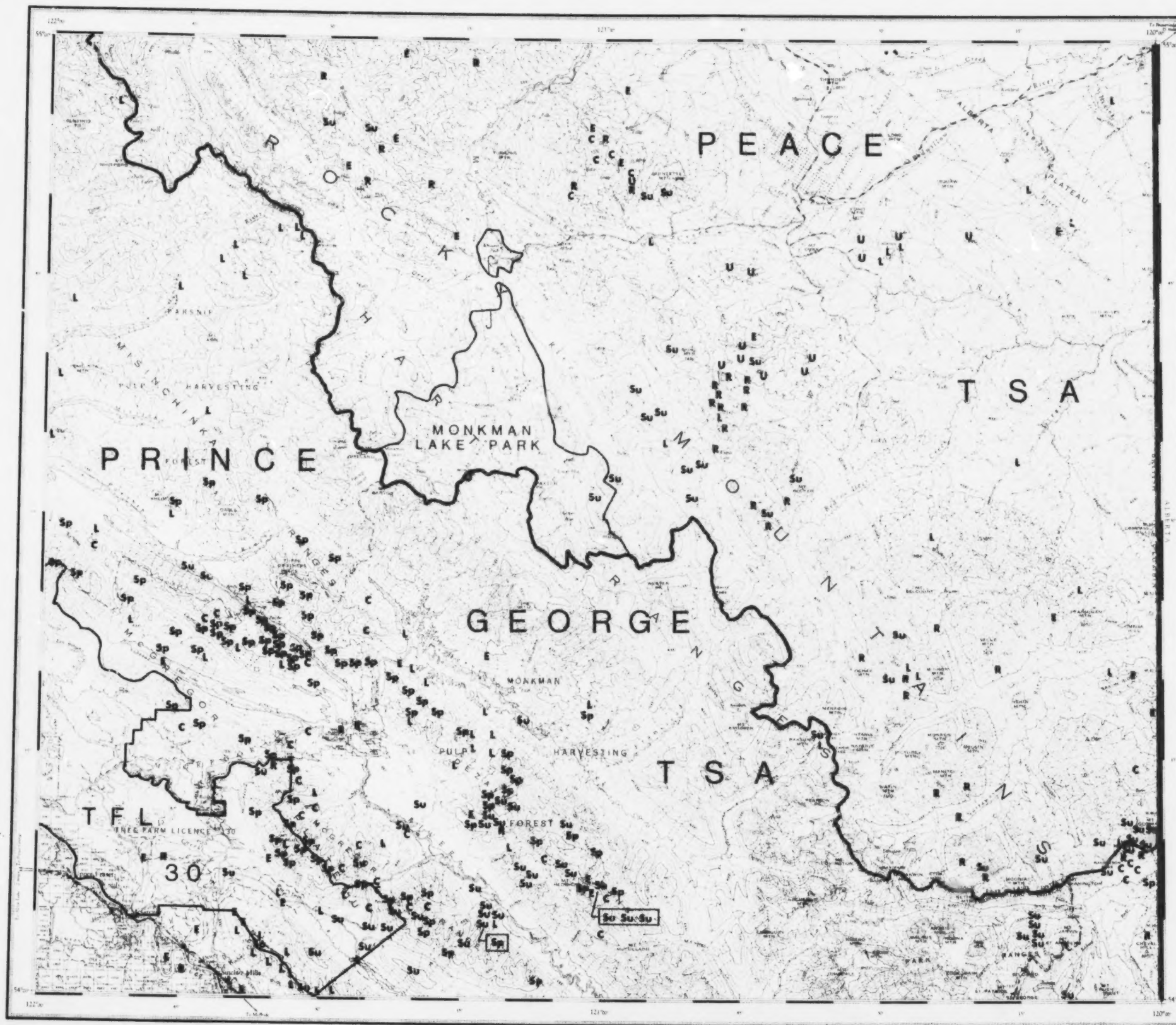
- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

MONKMAN PASS

Scale of Kilometres



WOODLAND CARIBOU — HABITAT
MAPSHEET 9a 93 I



LEGEND

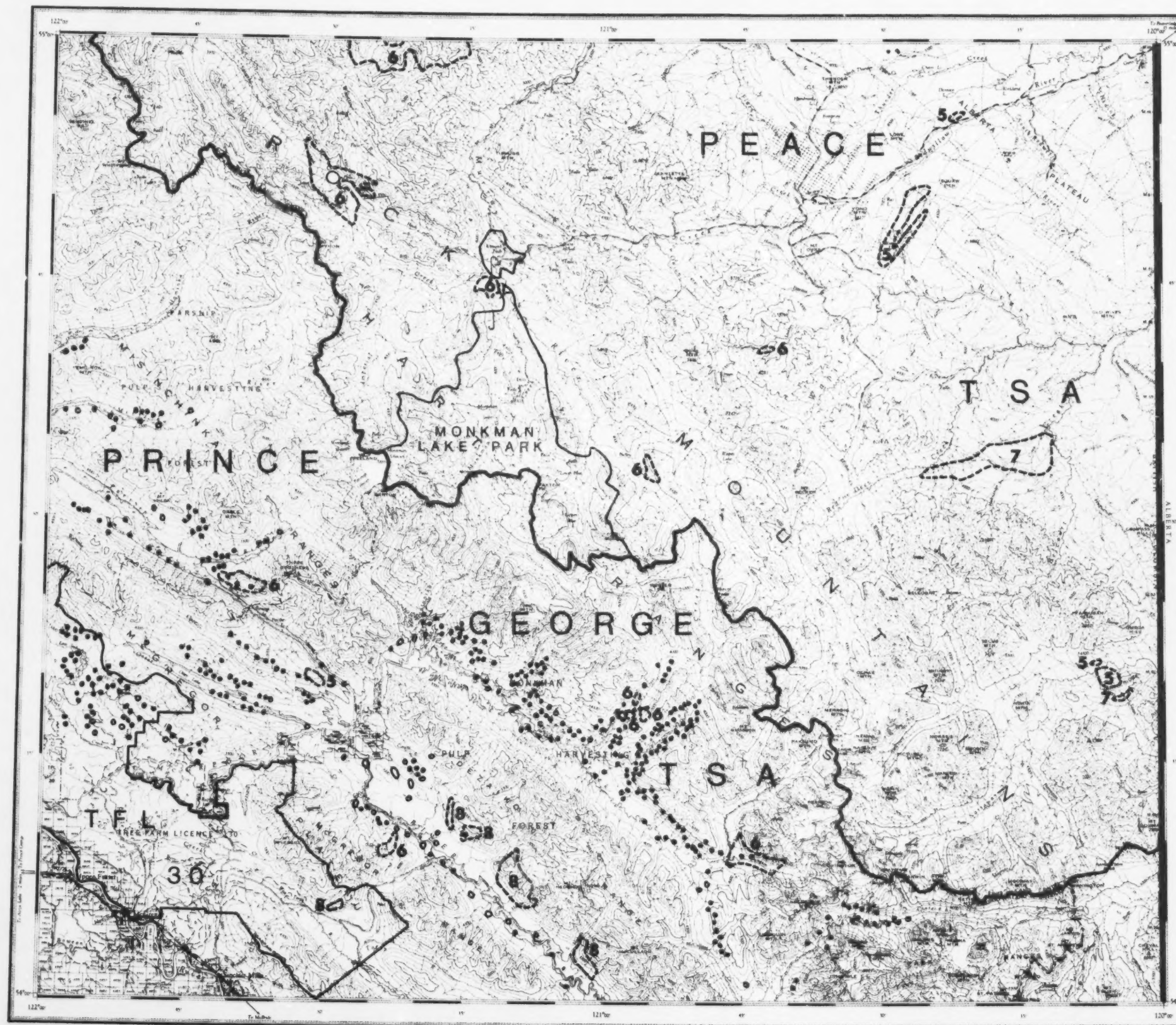
CARIBOU OBSERVATIONS

C	May 21 - June 10	Calving
Su	June 11 - Sept. 20	Summer
R	Sept. 21 - Oct. 20	Rut
E	Oct. 21 - Jan. 15	Early Winter
L	Jan. 16 - Mar. 31	Late Winter
Sp	Apr. 1 - May 20	Spring
U		Unspecified

MONKMAN PASS

Scale of Kilometres

WOODLAND CARIBOU — HABITAT
MAPSHEET 9b 93 I



LEGEND

FIRE HISTORY

- 4** 1940-49
- 5** 1950-59
- 6** 1960-69
- 7** 1970-79
- 8** 1980-81

INSECT ATTACK

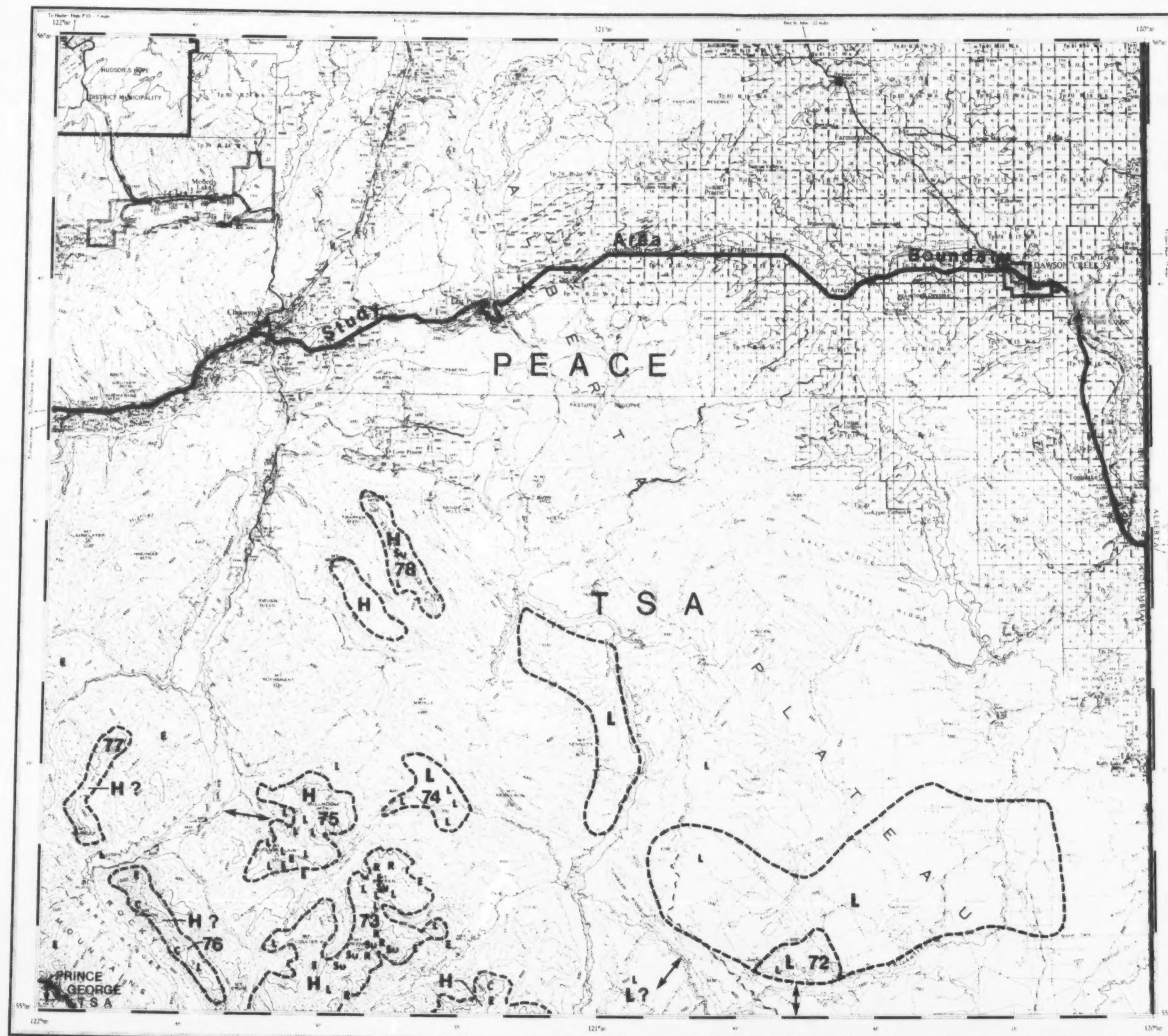
-  Spruce Bark Beetle
-  Mountain Pine Beetle

Source: CFS Mapping Program 1981

MONKMAN PASS

Scale of Kilometres
0 5 10 15 20

WOODLAND CARIBOU — HABITAT
MAPSHEET 9c 93 I



LEGEND

CARIBOU RANGES

- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

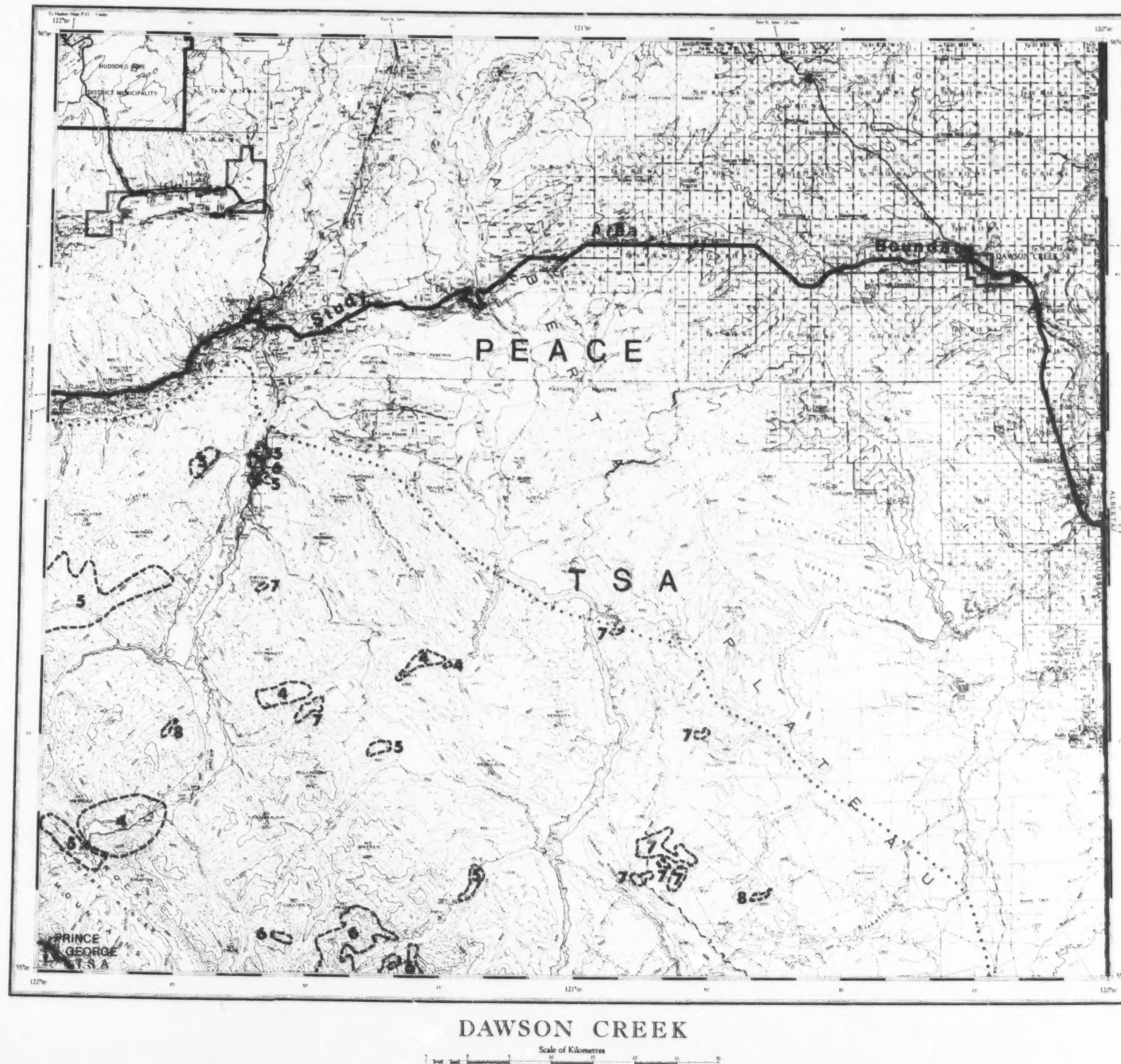
CARIBOU OBSERVATIONS

- | | | |
|----|--------------------|--------------|
| c | May 21 - June 10 | Calving |
| su | June 11 - Sept. 20 | Summer |
| r | Sept. 21 - Oct. 20 | Rut |
| e | Oct. 21 - Jan. 15 | Early Winter |
| l | Jan. 16 - Mar. 31 | Late Winter |
| sp | Apr. 1 - May 20 | Spring |
| u | | Unspecified |

DAWSON CREEK

Scale of Kilometres

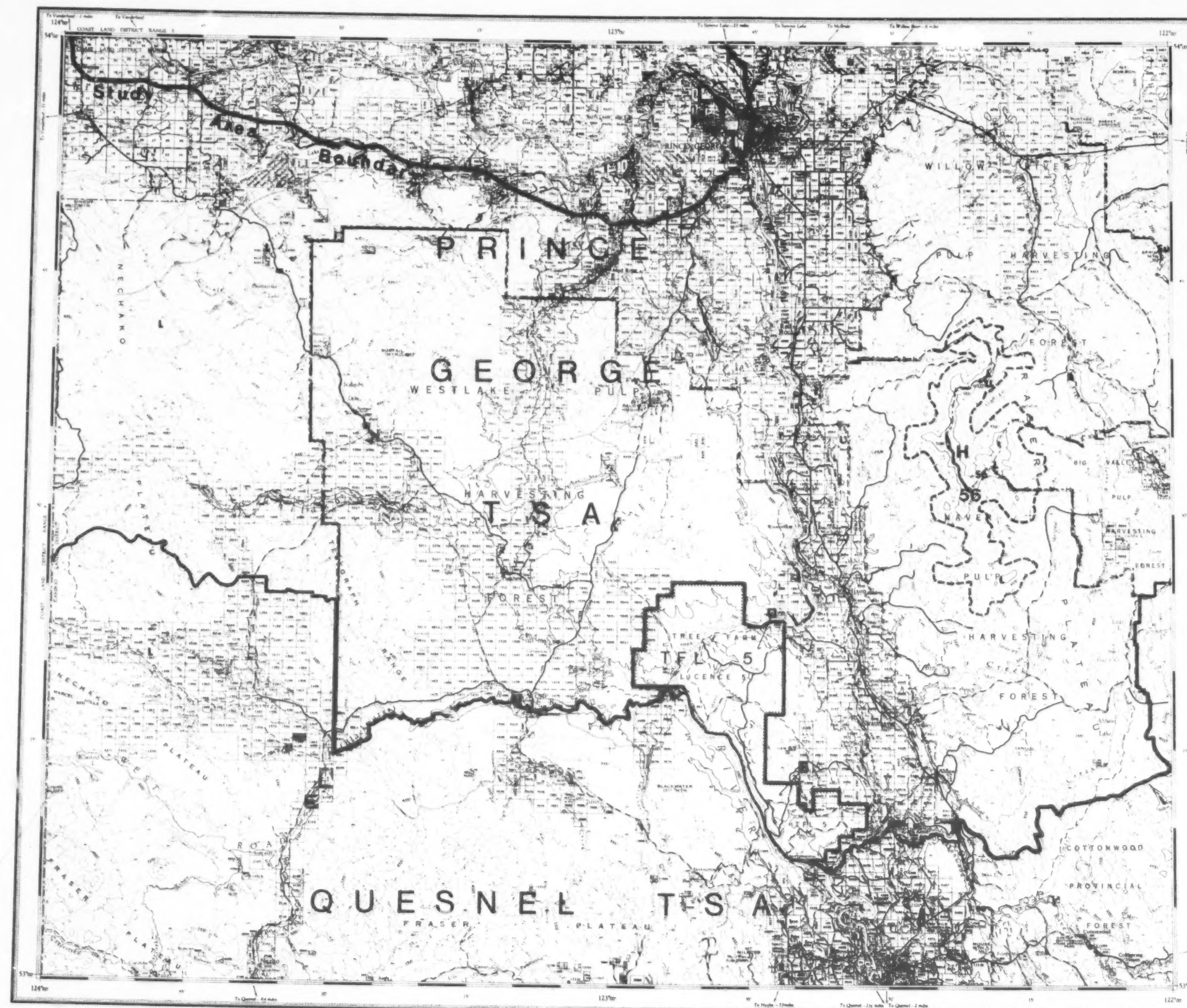
WOODLAND CARIBOU — HABITAT
MAPSHEET 10a 93 P



LEGEND

FIRE HISTORY

- 4** 1940-49
- 5** 1950-59
- 6** 1960-69
- 7** 1970-79
- 8** 1980-81
- Limit of Mapping



LEGEND

CARIBOU RANGES

- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

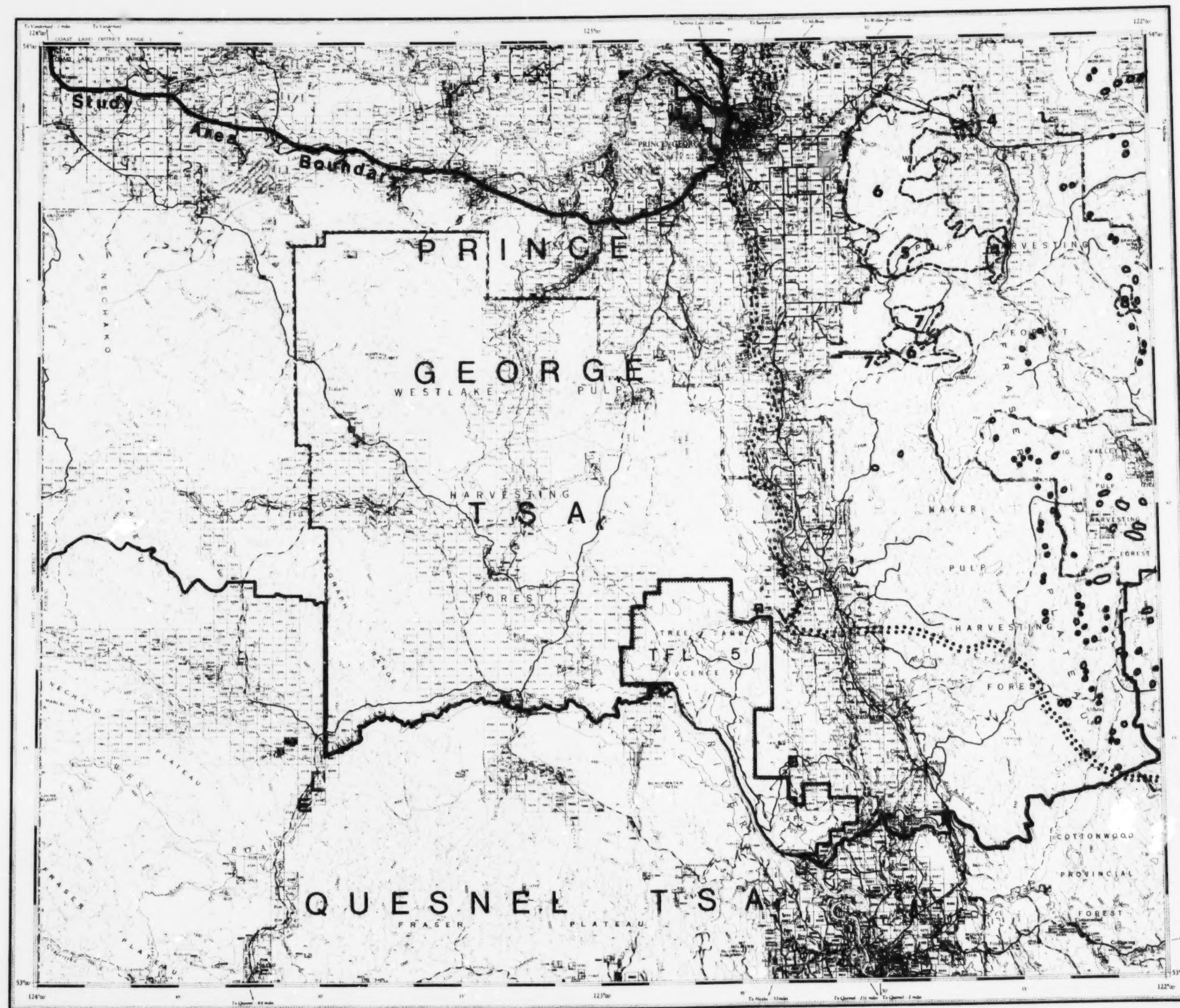
CARIBOU OBSERVATIONS

- | | | |
|-----------|--------------------|--------------|
| C | May 21 - June 10 | Calving |
| Su | June 11 - Sept. 20 | Summer |
| R | Sept. 21 - Oct. 20 | Rut |
| E | Oct. 21 - Jan. 15 | Early Winter |
| L | Jan. 16 - Mar. 31 | Late Winter |
| Sp | Apr. 1 - May 20 | Spring |
| U | | Unspecified |

PRINCE GEORGE

Scale of Kilometres
0 5 10 15 20 25 30

WOODLAND CARIBOU — HABITAT
MAPSHEET 11a 93 G



LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81

..... Limit of Mapping

INSECT ATTACK

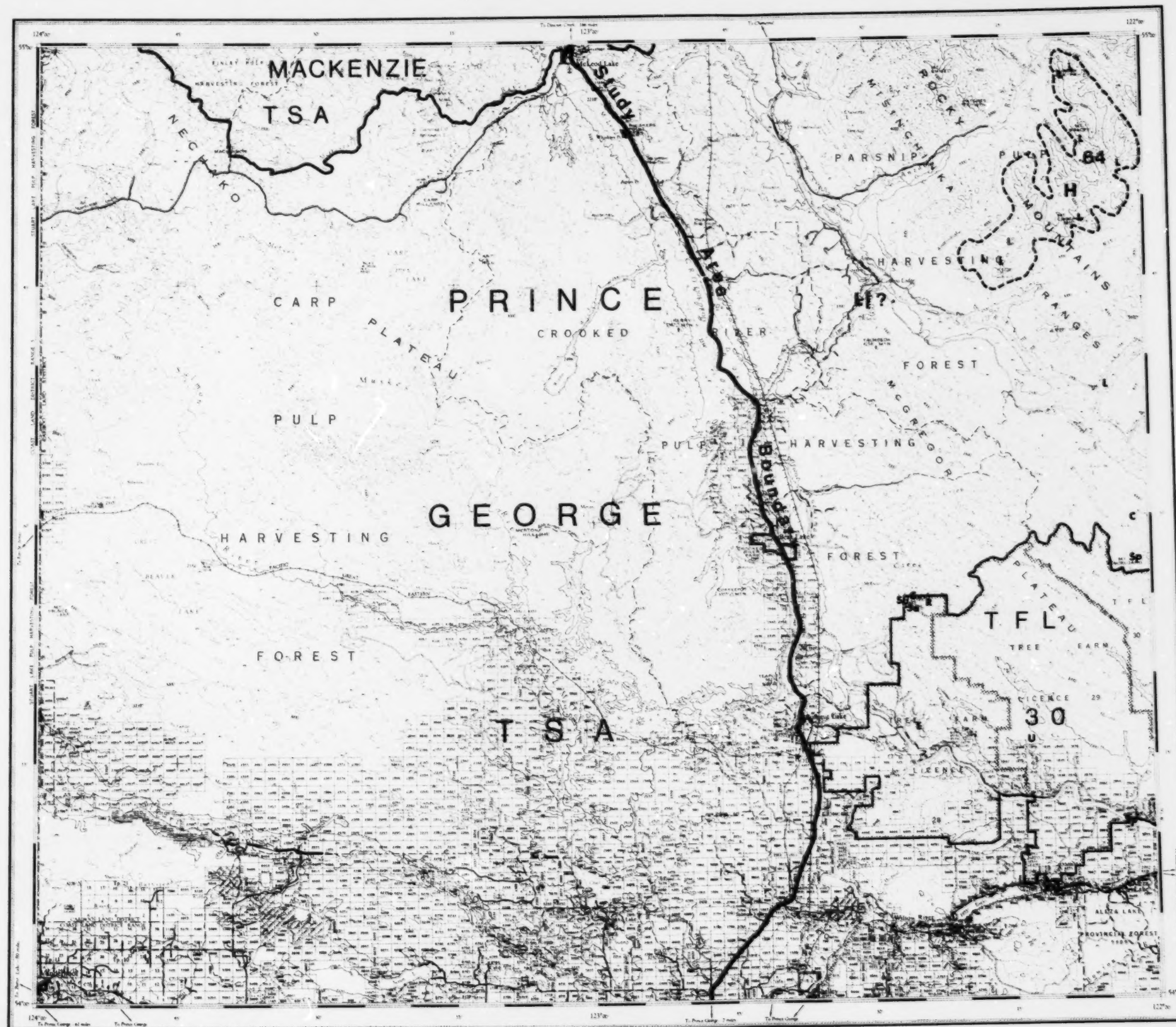
- Spruce Bark Beetle
- Mountain Pine Beetle
- Limit of Mapping

Source: CFS Mapping Program 1981

PRINCE GEORGE

Scale of Kilometres

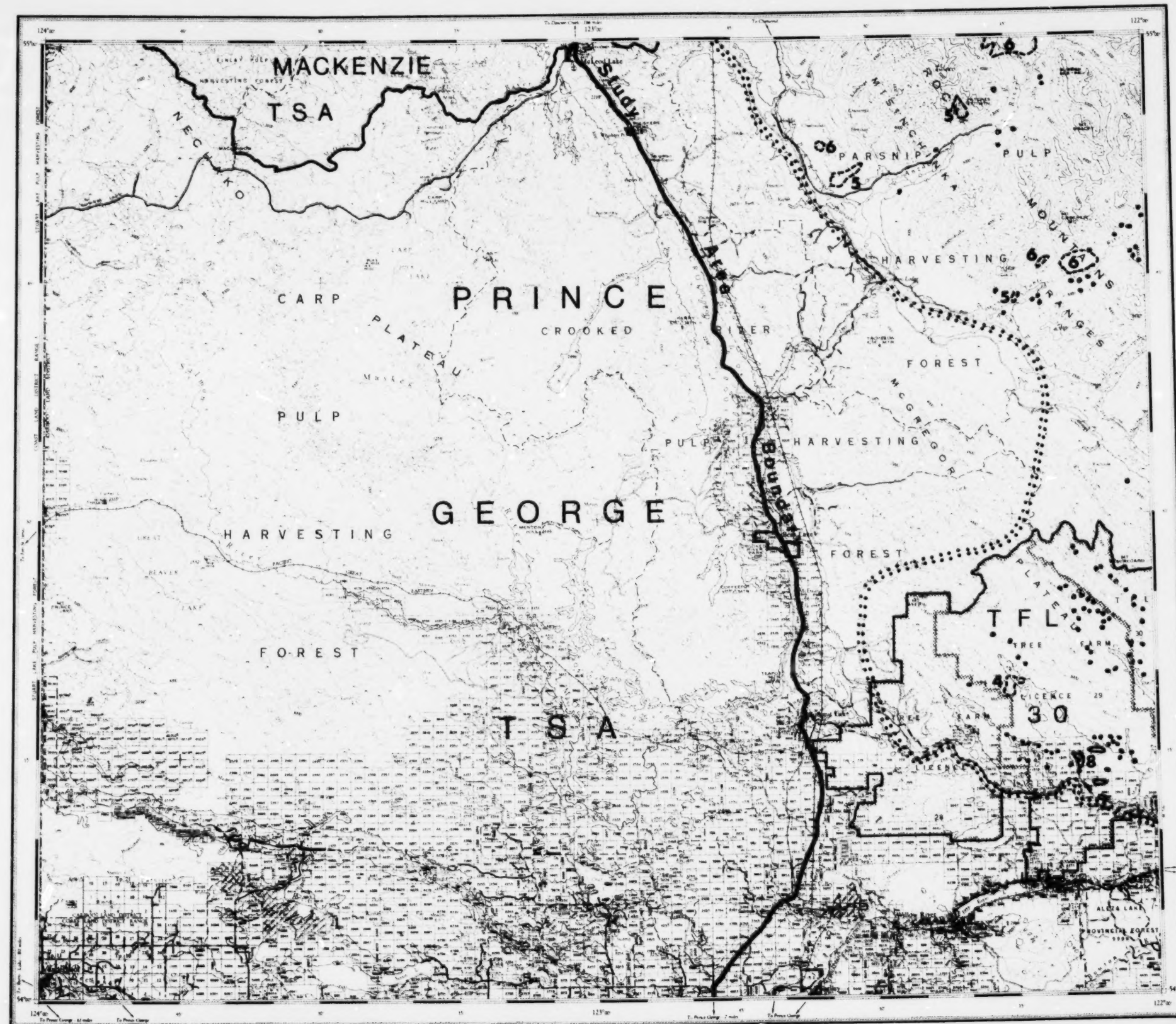
WOODLAND CARIBOU — HABITAT
MAPSHEET 11b 93 G



LEGEND

- CARIBOU RANGES**
- Use and Boundaries Known
 - Use Known; Boundaries Uncertain
 - Suspected Ranges
 - High Elevation Winter Range (May Include Summer Range)
 - Low Elevation Winter Range (May Include Fall and Spring Range)
 - Movement Routes
 - Mineral Lick
 - Reference Number for Mark IV Analysis

- CARIBOU OBSERVATIONS**
- c May 21 - June 10 Calving
 - su June 11 - Sept. 20 Summer
 - r Sept. 21 - Oct. 20 Rut
 - e Oct. 21 - Jan. 15 Early Winter
 - l Jan. 16 - Mar. 31 Late Winter
 - sp Apr. 1 - May 20 Spring
 - u Unspecified



LEGEND

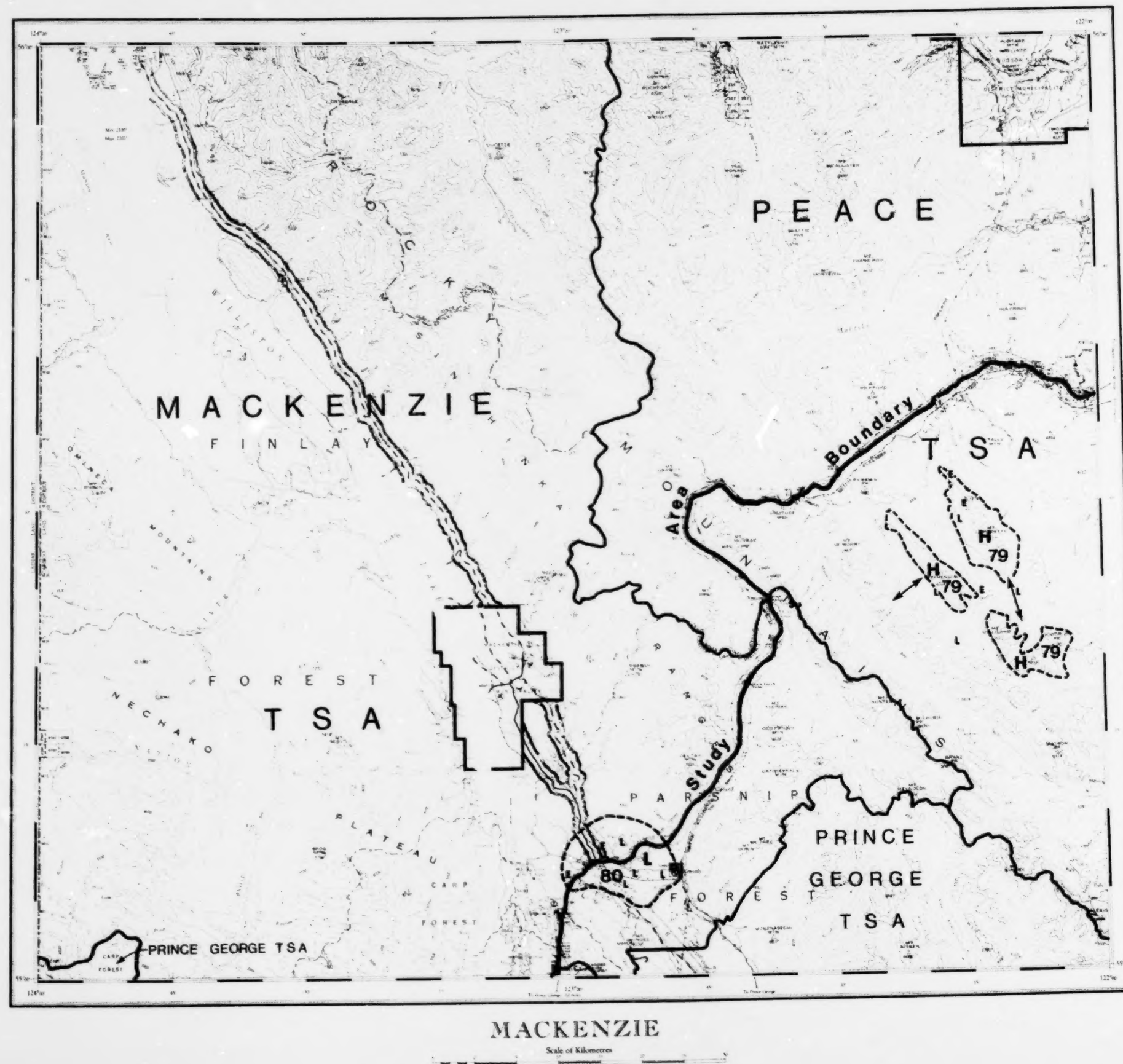
FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81
- Limit of Mapping

INSECT ATTACK

- Spruce Bark Beetle
- Mountain Pine Beetle
- Limit of Mapping

Source: CFS Mapping Program 1981



LEGEND

CARIBOU RANGES

- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

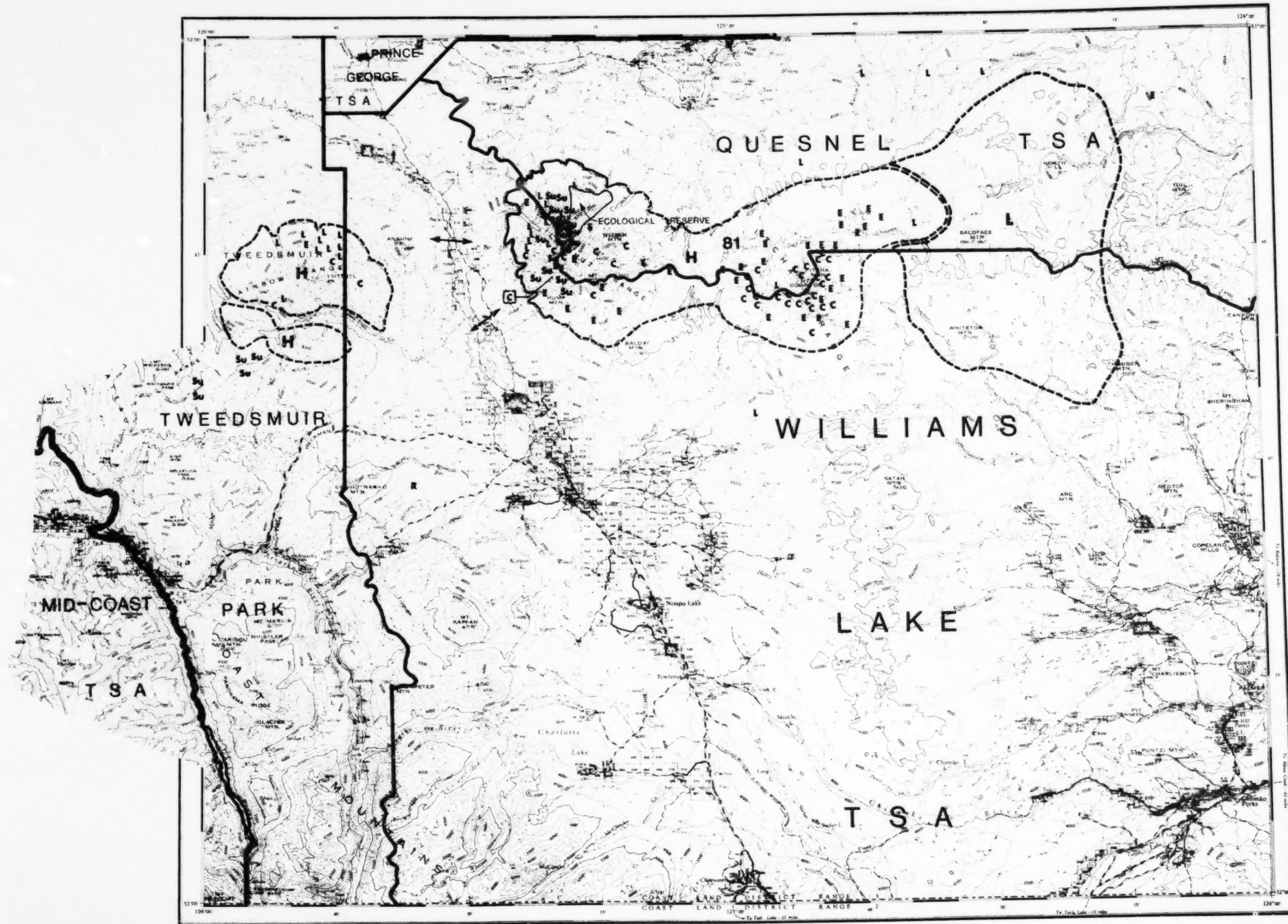
- | | | |
|-----------|--------------------|--------------|
| c | May 21 - June 10 | Calving |
| su | June 11 - Sept. 20 | Summer |
| r | Sept. 21 - Oct. 20 | Rut |
| e | Oct. 21 - Jan. 15 | Early Winter |
| l | Jan. 16 - Mar. 31 | Late Winter |
| sp | Apr. 1 - May 20 | Spring |
| u | | Unspecified |



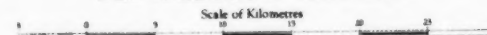
LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81



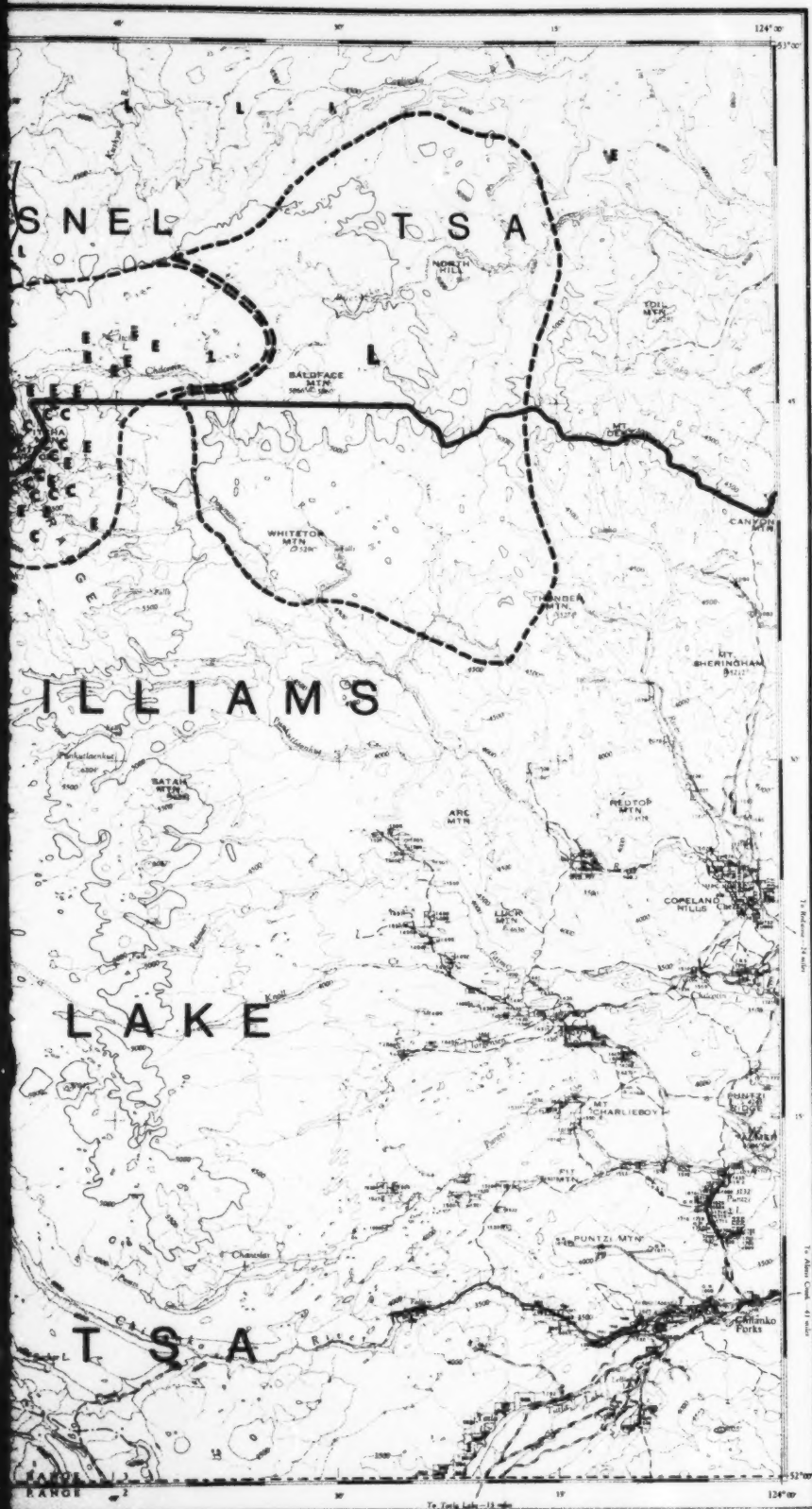
ANAHIM LAKE



3
H
L
8

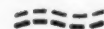
C
Su
R
E
L
Sp
U

WO



LEGEND

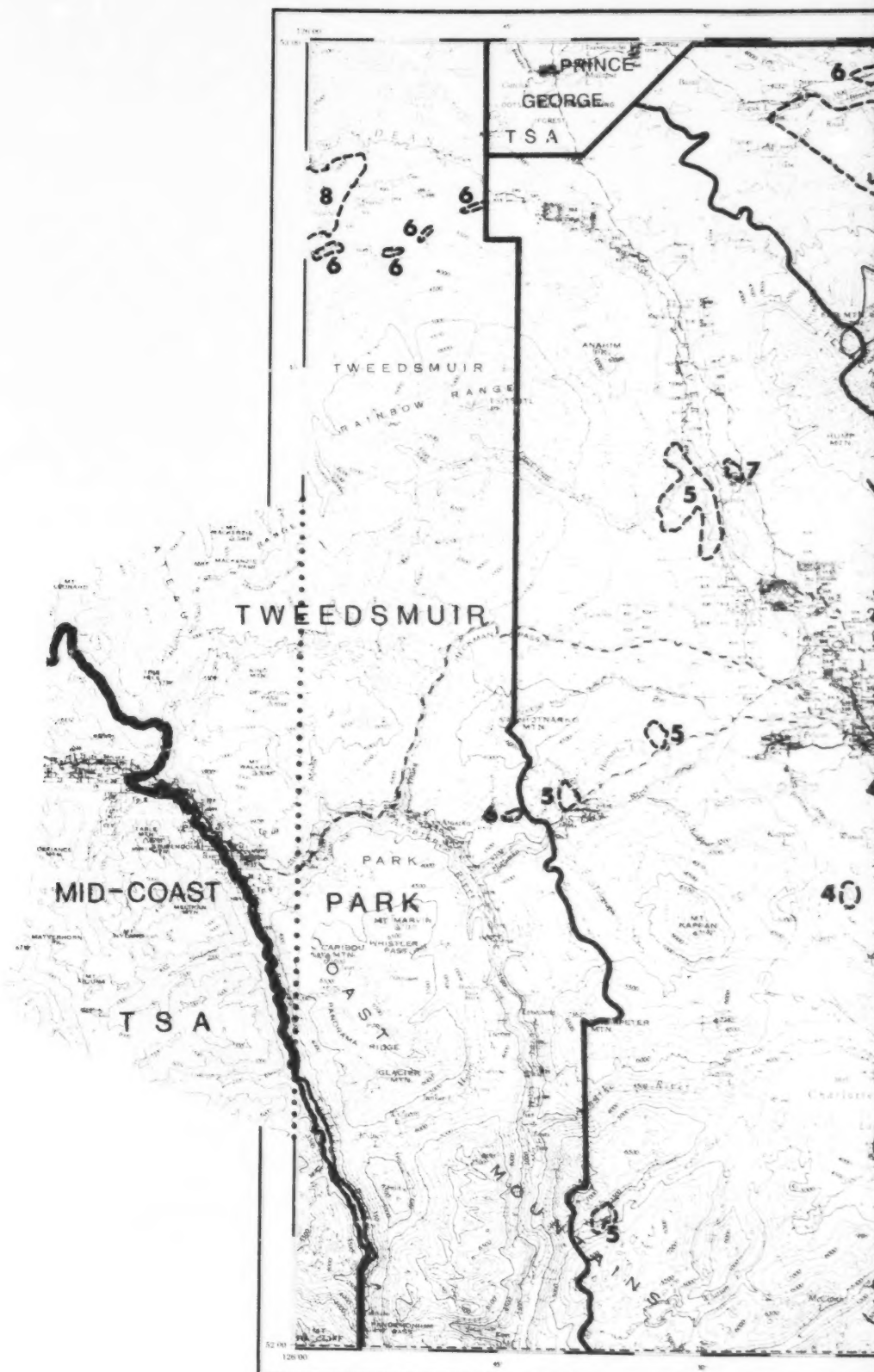
CARIBOU RANGES

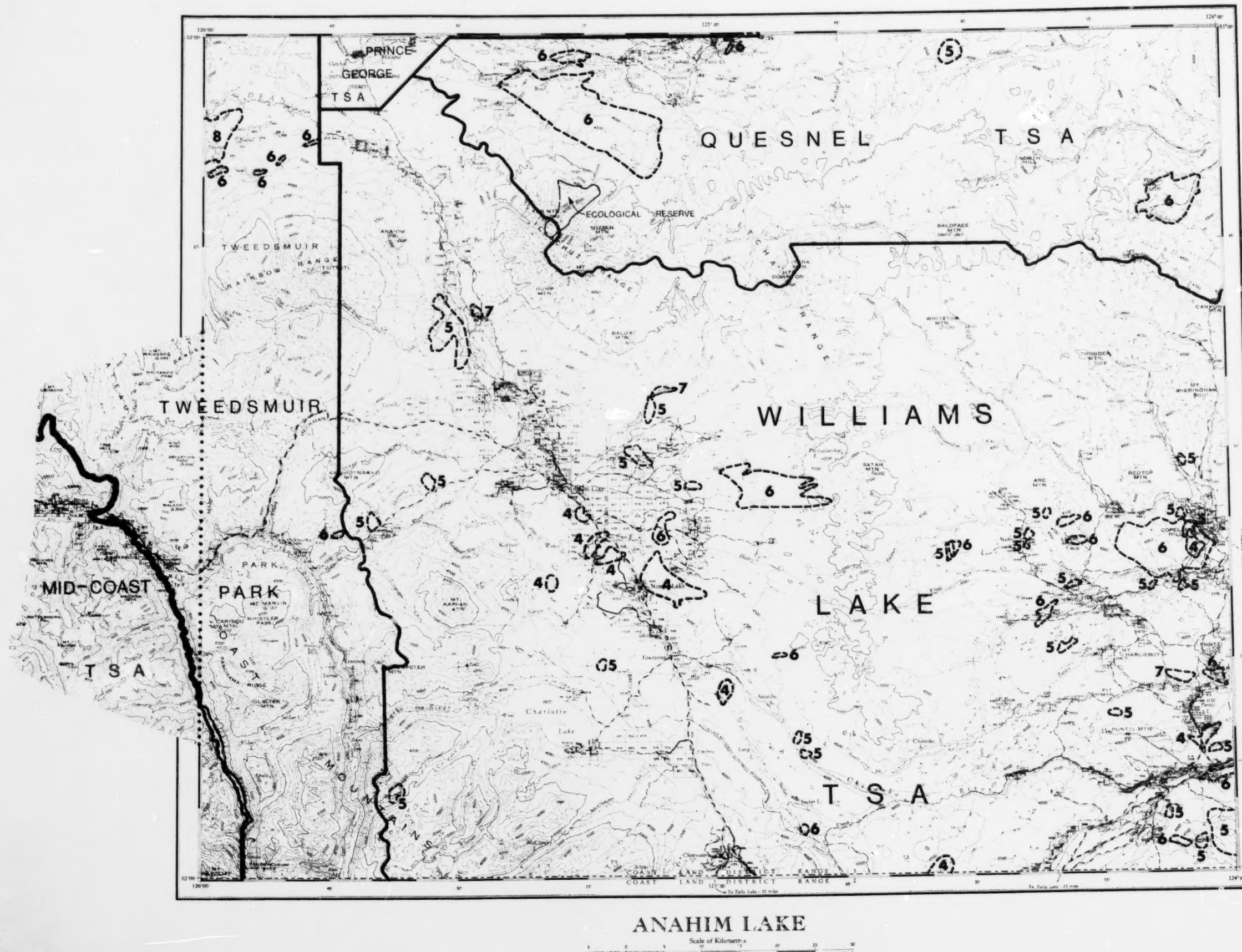
-  Use and Boundaries Known
-  Use Known; Boundaries Uncertain
-  Suspected Ranges
-  High Elevation Winter Range
(May Include Summer Range)
-  Low Elevation Winter Range
(May Include Fall and Spring Range)
-  Movement Routes
-  Mineral Lick
-  Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

- | | | |
|-----------|--------------------|--------------|
| c | May 21 - June 10 | Calving |
| Su | June 11 - Sept. 20 | Summer |
| R | Sept. 21 - Oct. 20 | Rut |
| E | Oct. 21 - Jan. 15 | Early Winter |
| L | Jan. 16 - Mar. 31 | Late Winter |
| Sp | Apr. 1 - May 20 | Spring |
| U | | Unspecified |

WOODLAND CARIBOU — HABITAT
MAPSHEET 14a 93 C



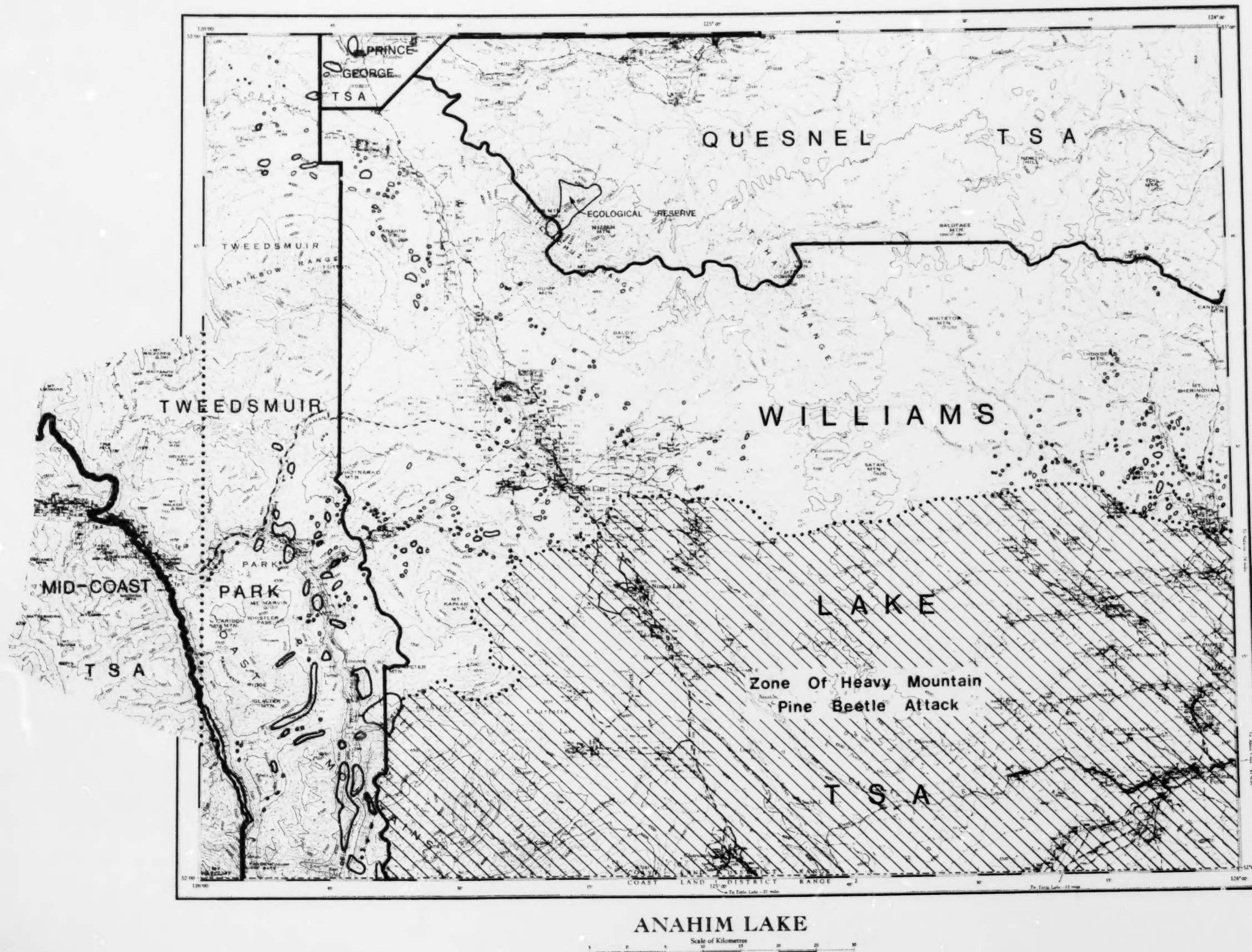


LEGEND

FIRE HISTORY

- 4** 1940-49
- 5** 1950-59
- 6** 1960-69
- 7** 1970-79
- 8** 1980-81
- Limit of Mapping

WOODLAND CARIBOU — HABITAT
MAPSHEET 14b 93 C

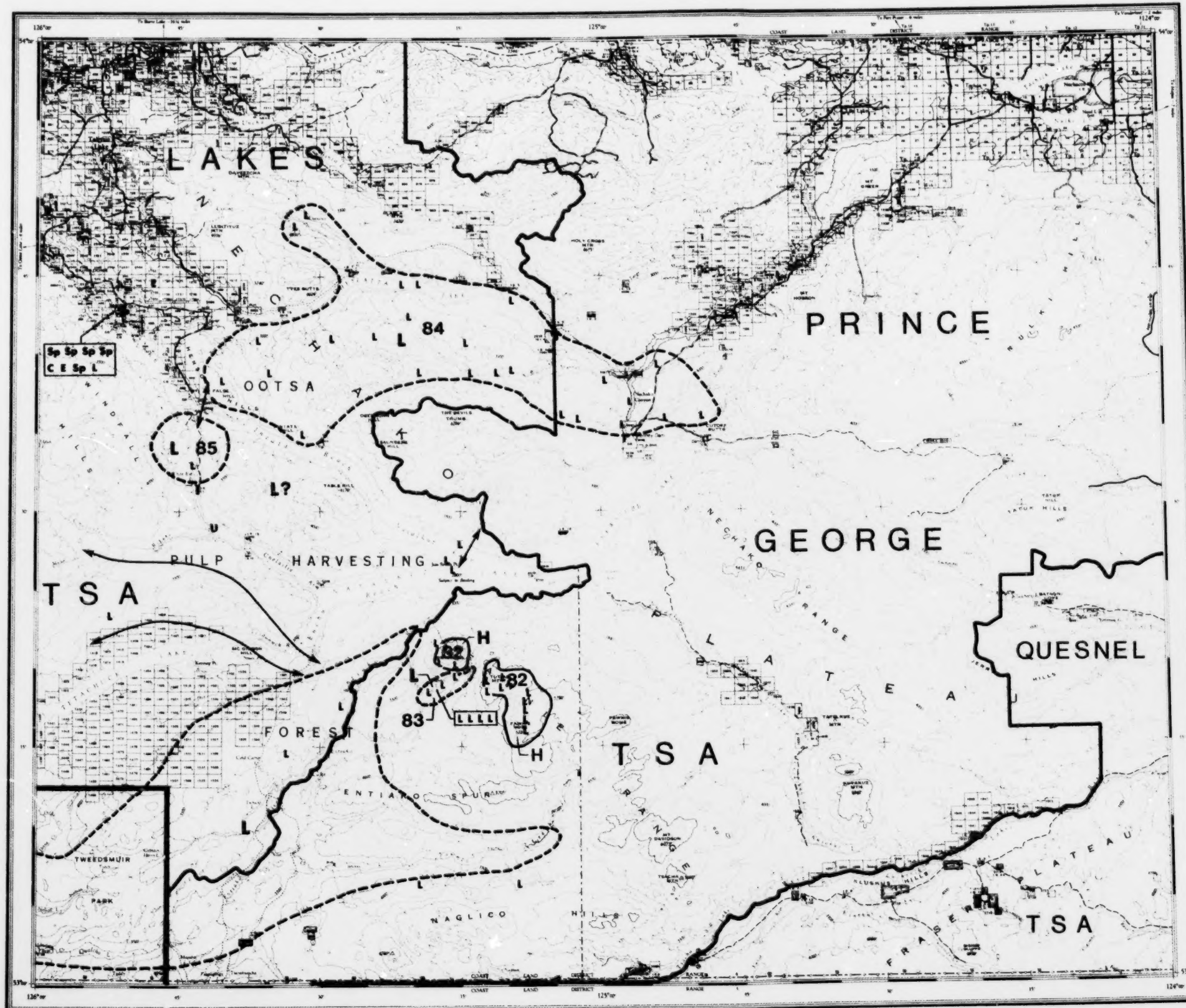


LEGEND

INSECT ATTACK

-  Spruce Bark Beetle
-  Mountain Pine Beetle
-  Limit of Mapping

Sources: Caribou Regional Mapping 1981
Prince Rupert Regional Mapping 1981



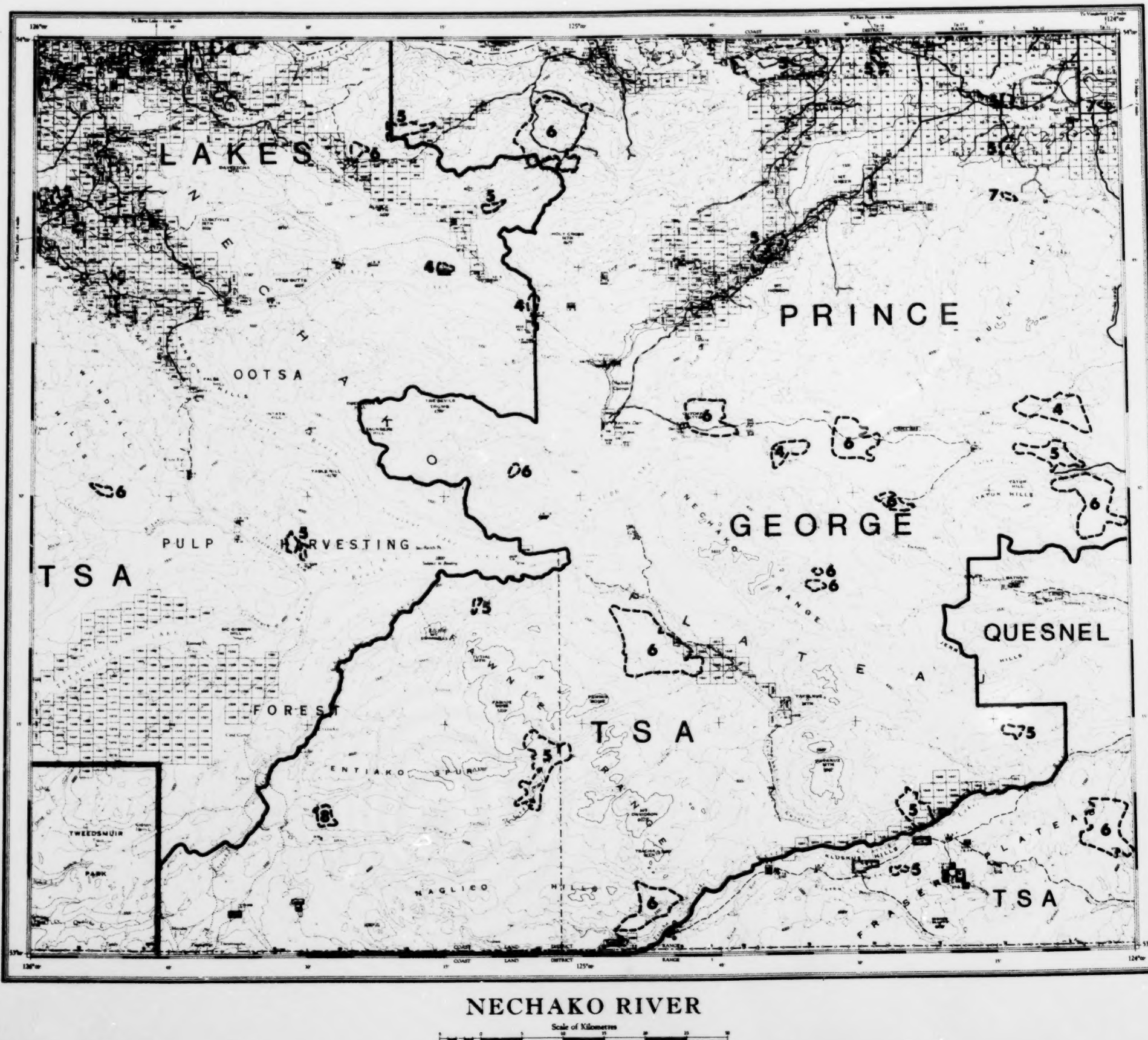
LEGEND

CARIBOU RANGES

- Use and Boundaries Known
- Use Known; Boundaries Uncertain
- Suspected Ranges
- High Elevation Winter Range
(May Include Summer Range)
- Low Elevation Winter Range
(May Include Fall and Spring Range)
- Movement Routes
- Mineral Lick
- Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

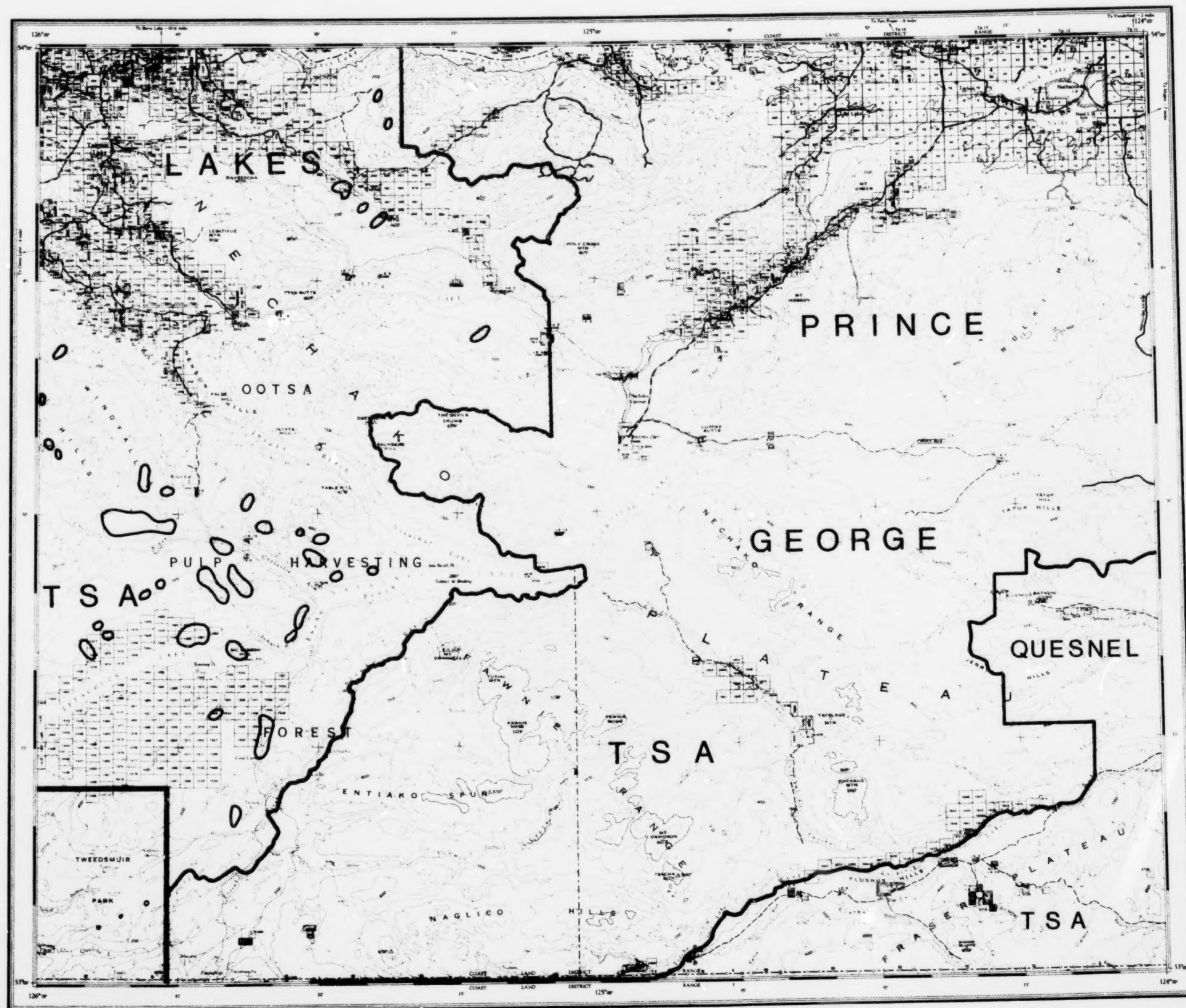
- | | | |
|----|--------------------|--------------|
| c | May 21 - June 10 | Calving |
| su | June 11 - Sept. 20 | Summer |
| r | Sept. 21 - Oct. 20 | Rut |
| e | Oct. 21 - Jan. 15 | Early Winter |
| l | Jan. 16 - Mar. 31 | Late Winter |
| sp | Apr. 1 - May 20 | Spring |
| u | | Unspecified |



LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81



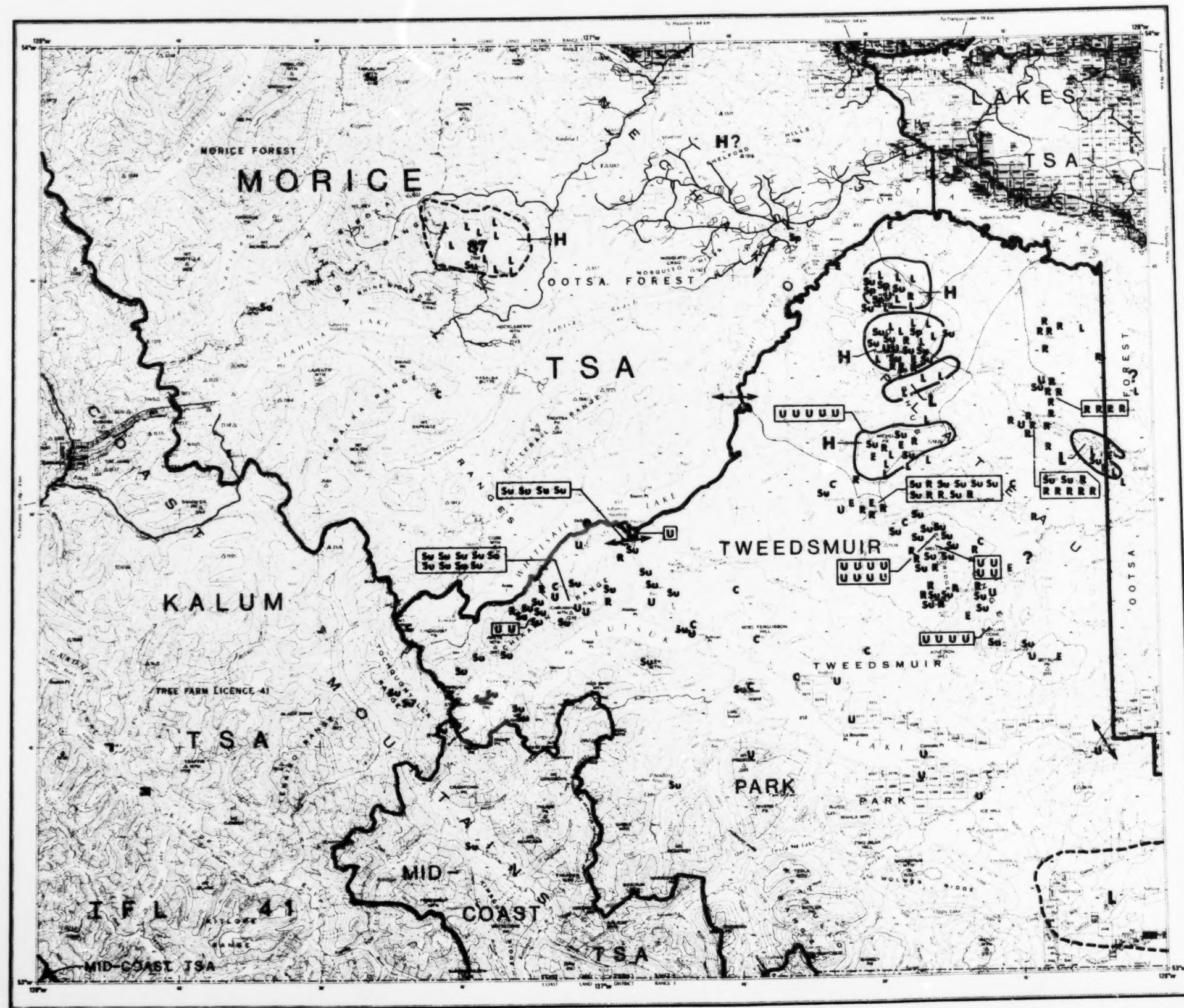
LEGEND

INSECT ATTACK

- Spruce Bark Beetle
- - - Mountain Pine Beetle
- Limit of Mapping

Sources: Lakes Forest District Mapping
 Prince Rupert Forest Region Mapping (Tweedsmuir
 Park Only)

WOODLAND CARIBOU — HABITAT
 MAPSHEET 15c 93 F

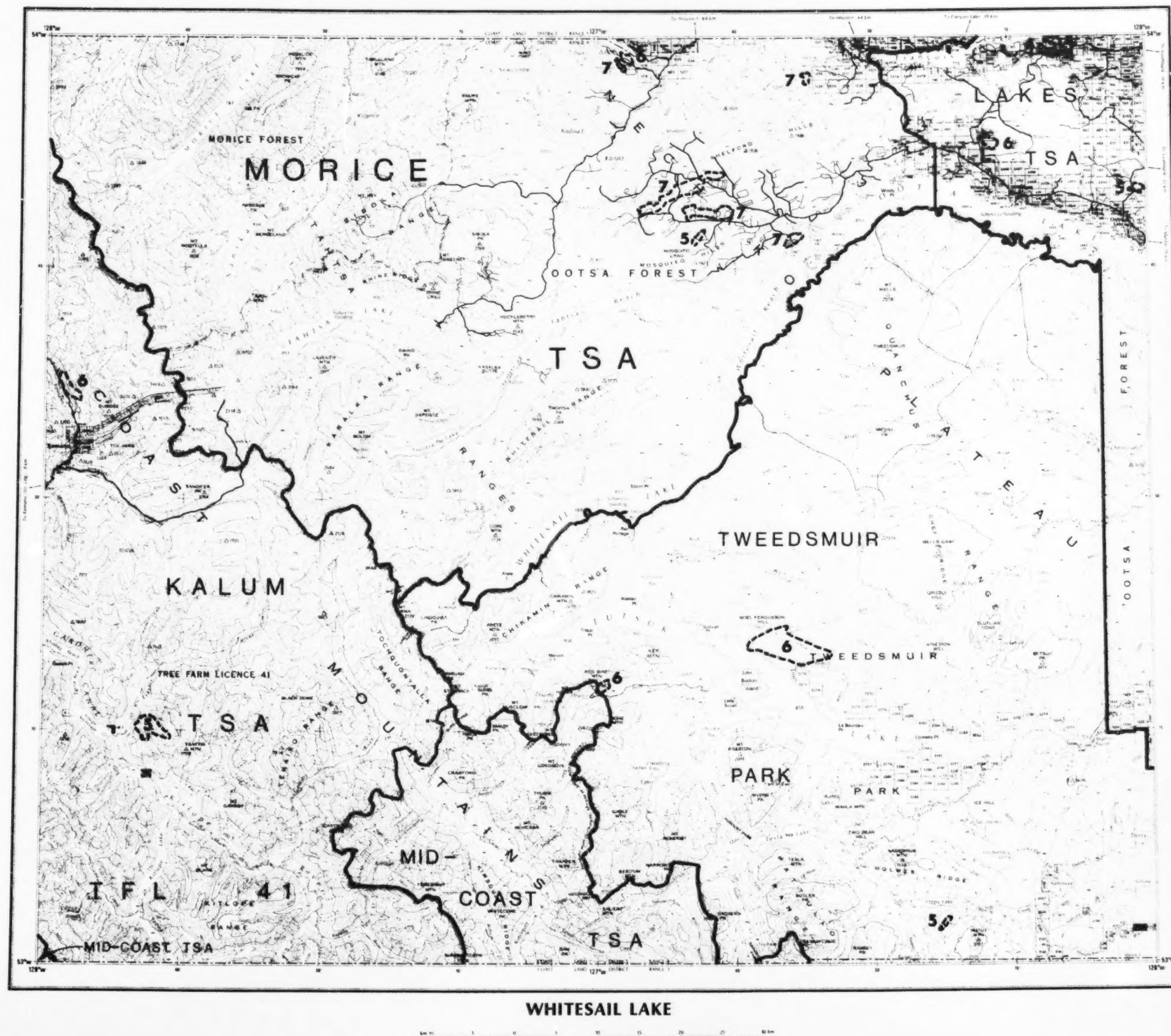


LEGEND

- CARIBOU RANGES**
- Use and Boundaries Known
 - Use Known; Boundaries Uncertain
 - Suspected Ranges
 - High Elevation Winter Range (May Include Summer Range)
 - Low Elevation Winter Range (May Include Fall and Spring Range)
 - Movement Routes
 - Mineral Lick
 - Reference Number for Mark IV Analysis

CARIBOU OBSERVATIONS

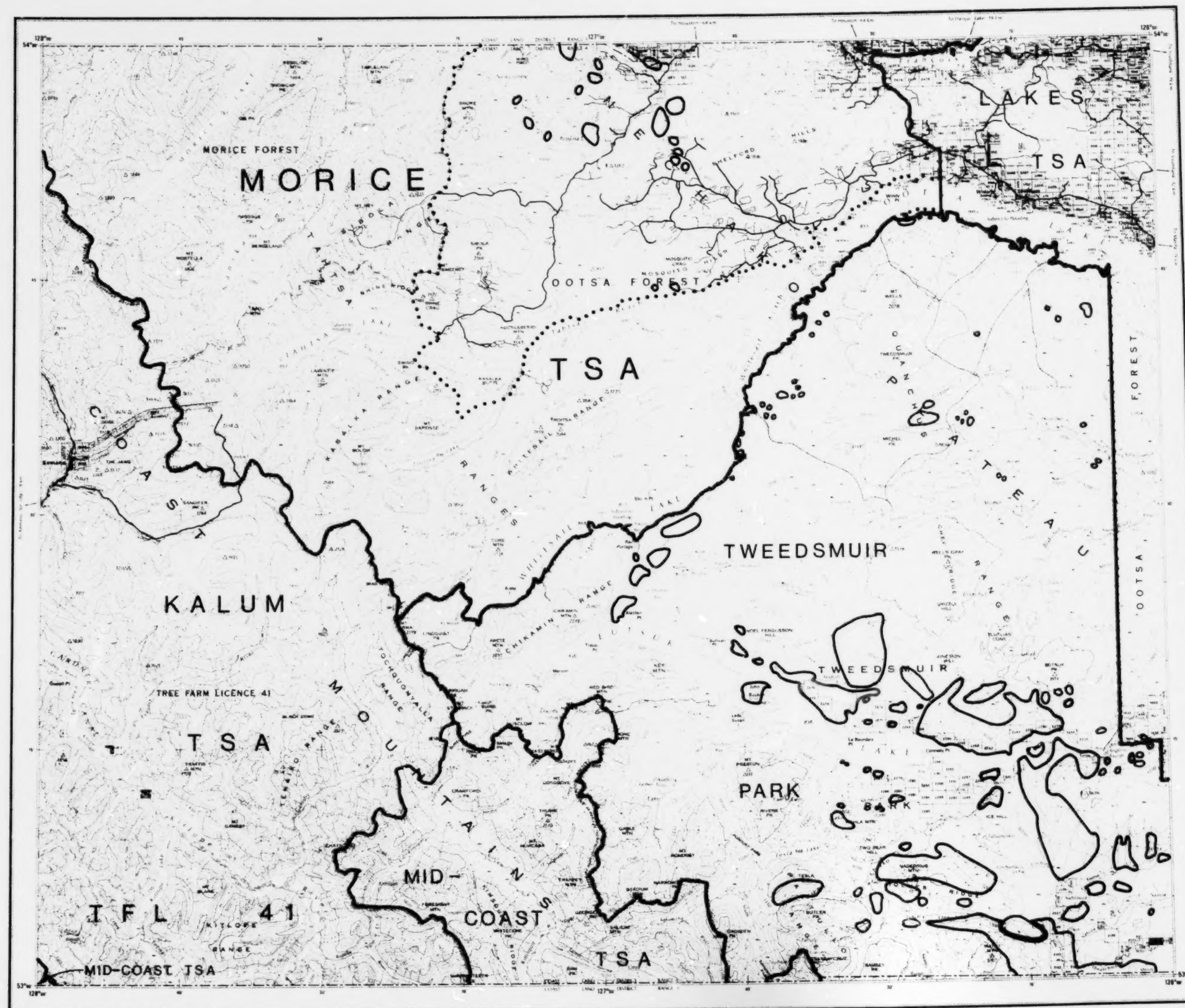
- | | | |
|----|--------------------|--------------|
| c | May 21 - June 10 | Calving |
| Su | June 11 - Sept. 20 | Summer |
| R | Sept. 21 - Oct. 20 | Rut |
| E | Oct. 21 - Jan. 15 | Early Winter |
| L | Jan. 16 - Mar. 31 | Late Winter |
| Sp | Apr. 1 - May 20 | Spring |
| U | | Unspecified |



LEGEND

FIRE HISTORY

4	1940-49
5	1950-59
6	1960-69
7	1970-79
8	1980-81



LEGEND

INSECT ATTACK

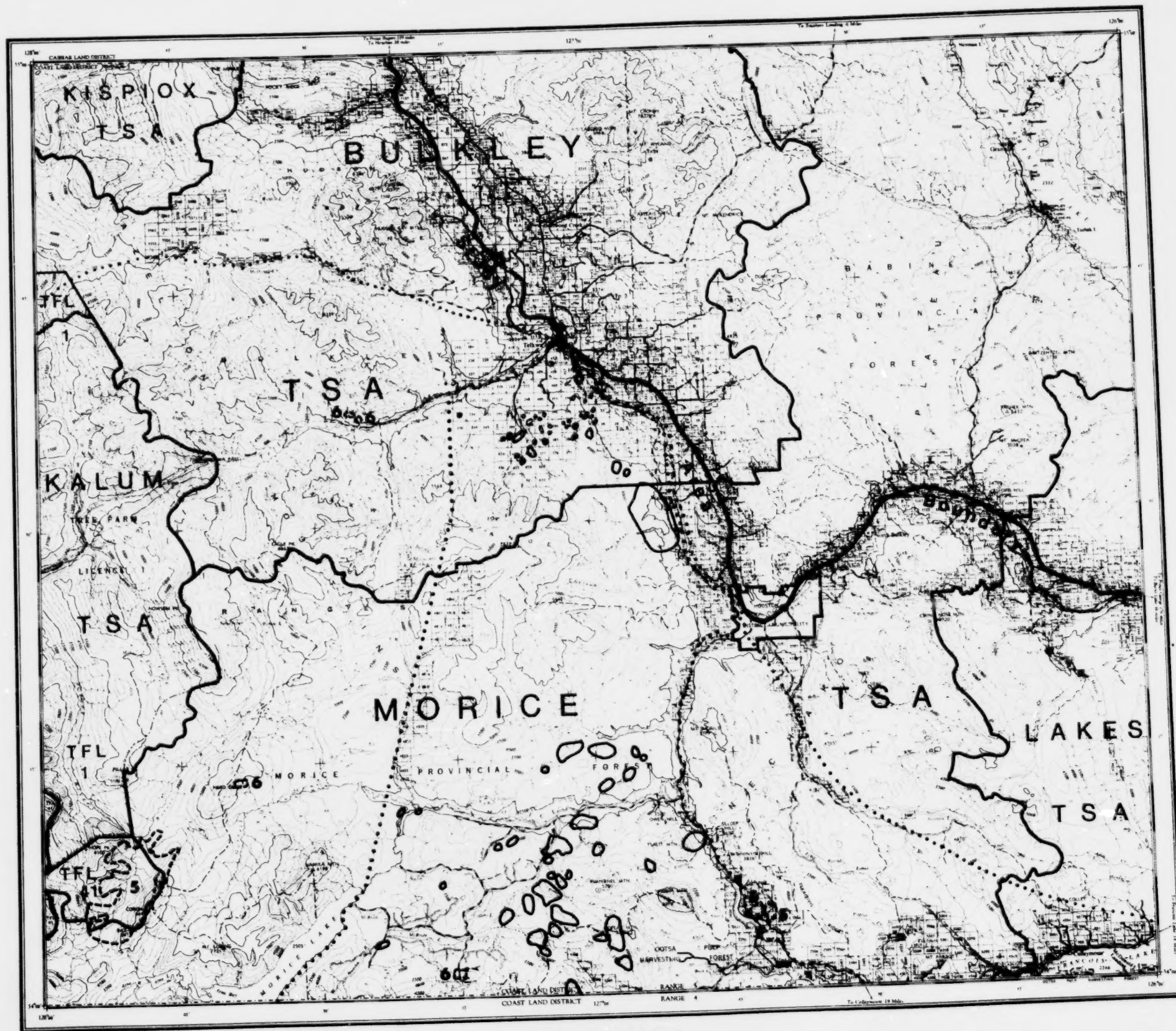
Spruce Bark Beetle

Mountain Pine Beetle

Limit of Mapping

Sources: Prince Rupert Forest Region Mapping 1981
Morice Forest District Mapping 1981-82

WOODLAND CARIBOU — HABITAT
MAPSHEET 16c 93 E



LEGEND

FIRE HISTORY

- 4 1940-49
- 5 1950-59
- 6 1960-69
- 7 1970-79
- 8 1980-81
- Limit of Mapping

INSECT ATTACK

- ~~~~~ Spruce Bark Beetle
- ~~~~~ Mountain Pine Beetle
- Limit of Mapping

Sources: Bulkley Forest District Mapping
Morice Forest District Mapping 1981-82

WOODLAND CARIBOU — HABITAT
MAPSHEET 17b 93 L